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GEOLOGICAL SURVEY WATER-SUPPLY PAPER 2079

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By PHILLIP E. GREESON

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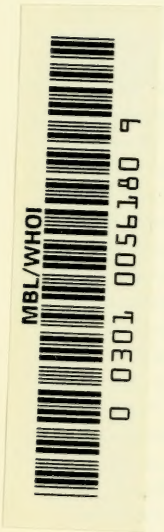

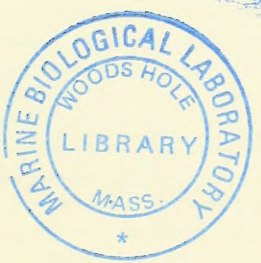

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1982

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, *Secretary*

GEOLOGICAL SURVEY
Dallas L. Peck, *Director*

Library of Congress catalog-card No. 81-600168

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

CONTENTS

ILLUSTRATIONS

TABLES

A Note on the Illustrations in this Book:

The drawings of alga genera shown in figures 1, 2, 3, 4, 6, 7, 9, 10, 13, 16, 17, 18, 19, 20, 32, 43, 46, 47, 48, 53, 54, 57, 58 were redrawn from originals in Smith, 1950, published by the McGraw-Hill Book Company and are shown here under license from McGraw-Hill. The scanning electron-micrographs were made by Bruce W. Lium and W. Thomas Shoaf III, U.S. Geological Survey. The photomicrographs were made by the author.

AN ANNOTATED KEY TO THE IDENTIFICATION OF COMMONLY OCCURRING AND DOMINANT GENERA OF ALGAE OBSERVED IN THE PHYTOPLANKTON OF THE UNITED STATES

By PHILLIP E. GREESON

ABSTRACT

In early 1979, a retrieval was made for all phytoplankton data contained in the computerized data file of the U. S. Geological Survey. The retrieval revealed the analytical results of 17,959 samples collected and processed between October 1973 and October 1978. Of the approximately 500 genera of freshwater algae reported in the United States, the U.S. Geological Survey observed 321 genera in the phytoplankton. Fifty-two genera were considered to be commonly occurring and 42 genera were considered to be community dominants. The report lists, describes, and provides a detailed taxonomic key to the identification of 58 genera of algae considered either commonly occurring or dominant. Also included is a summary of environmental conditions under which each algal genus was observed, as well as a glossary and an extensive list of selected references.

INTRODUCTION

Taxonomy is the science concerned with the orderly arrangement of organisms in some scheme of likenesses and differences among the various individuals. The present taxonomic system was developed mostly during the 18th and 19th centuries. During the mid-1800's, taxonomy played an additional and equally important role, that being the basic tool in the analysis of evolutionary relationships among organisms. This is commonly called the science of systematics. It was in the early-1900's when investigators began to realize that organisms not only had certain inherent relationships but also were sensitive to changes in the environment.

Since the beginning of the 20th century, numerous publications have discussed algae as indicators of environmental conditions. Perhaps the most important contribution on ecological indicators was by Kolkwitz and Marrson (1908), who introduced the concept of indicator species. This resulted in the "saprobian" system for classifying organisms in organically polluted rivers.

After the paper by Kolkwitz and Marrson, many similar papers were published; all discussed indicator species. The importance of biological indicators as an index of pollution was described by Forbes (1913),

when he stated that "* * * it is quite possible to arrange plants and animals of a stream in the order of their preference for, or tolerance of, organic impurities, in such a way that a graded list of them may serve as an index to grades of contamination."

W. C. Purdy (1922), a plankton specialist with the U.S. Public Health Service, clearly recognized the value of biological indicators when he concluded, "If it be true that the biological life of a stream is distinctly and profoundly affected by the numerous factors which form the environment, it follows that the organisms in a stream constitute in a general way a reflection of the prevailing environmental conditions of the stream."

Thienemann (1939) was the first to demonstrate that groups of species were characteristic of a given type of environment. Community structure as an indicator of environmental conditions thereby became a firmly established concept. Fjerdingstad (1950) was the first to consider algal community-dominant species, associate species, and accidental species. Perhaps the most well known paper considering community structure as an indicator was by Patrick (1949). In it, she coined the terms "healthy," "semihealthy," "polluted," and "very polluted" to describe the variability one might expect in the organisms and yet indicate the degree of degradation that had taken place in a stream.

Subsequent to Patrick's paper, the emphasis changed from studies that were purely qualitative in nature to quantitative expressions of community structures, associations, and diversities.

With the realization of the importance of biota as indicators and of the need to characterize the quality of water, including the biological quality, in major waterways of the United States, the U.S. Public Health Service initiated the National Water Quality Network in 1957. Samples for determining the physical, chemical, and biological quality at 128 stations were collected through 1962 (Williams, 1962, 1964, 1966). The network continued until the late 1960's as the Water Pollution Surveillance System under the purview of the Federal Water Pollution Control Administration (now the U.S. Environmental Protection Agency) (Weber, 1966).

The changing emphasis toward the preservation of environmental quality during the 1960's awakened the need for a long-term data base with which changes in water quality could be determined. As a result, the U.S. Geological Survey initiated the National Stream-Quality Accounting Network (NASQAN) in 1973. NASQAN is a series of stations at which systematic and continuing measurements are made to determine the quality of the Nation's streams. Design of the network specifies measurement of a broad range of water-quality characteristics, including biological characteristics, which were selected to meet many of the information requests of groups involved

in planning and management on a national or regional scale. The primary objectives of NASQAN are (1) to account for the quantity and quality of surface water moving within and from the United States, (2) to depict areal variability, (3) to detect changes in stream quality, and (4) to provide the groundwork for future assessments of changes in stream quality (Ficke and Hawkinson, 1975).

As part of NASQAN, phytoplankton samples are obtained seven times a year from about 540 stations. The samples are processed for generic identification and enumeration by the U.S. Geological Survey's Central Water-Quality Laboratory in Atlanta, Ga., in accord with the methods of Greeson and others (1977) and Greeson (1979). All data are stored in the computerized data files (WATSTORE and BIOTAB) of the U.S. Geological Survey.

In early 1979, a retrieval was made for all phytoplankton data contained in BIOTAB. The data included those collected as part of NASQAN, as well as those data collected as part of other activities of the U.S. Geological Survey. About 80 percent of the file represented NASQAN data. During the 5-year period between October 1973 and October 1978, a total of 17,959 phytoplankton samples were processed. Using the almost 18,000 samples as a basis, this publication lists, describes, and provides a detailed taxonomic key for the identification of commonly occurring and dominant genera of algae observed in the phytoplankton of the United States. A summary of environmental conditions under which each algal genus was observed is included. Also included is a glossary and an extensive list of selected references.

Of the approximately 500 genera of freshwater algae reported in the United States (Greeson, 1970), the U.S. Geological Survey has observed 321 genera in the phytoplankton (table 1). Fifty-two genera reported in 5 percent or more of the samples were considered to be commonly occurring (table 2). Forty-two genera were dominant in 1 percent or more of the samples (table 3). A dominant genus was considered to be one that comprises 15 percent or more of the total cell count of a sample. Table 4 lists in alphabetical order by taxonomic groupings the 58 genera of algae that were either commonly occurring or dominant in the samples.

ACKNOWLEDGMENT

The author acknowledges with sincerest appreciation the many persons of the U.S. Geological Survey who made this publication possible. A special thanks is extended to James M. Bergmann, developer of BIOTAB, for his assistance with data retrievals; to the field personnel who performed their duties under extremely demanding conditions; and to the supervisors and analysts in the U.S. Geological Survey's laboratory in Atlanta for their perseverance in spite of an overwhelming number of samples.

TABLE 1.—*List of algal genera observed in the phytoplankton of the United States*

CHLOROPHYTA (Green algae)

Acanthosphaera
Actidesmium
Actinastrum
Ankistrodesmus
Ankyra
Arthrodesmus
Asterococcus

Bambusina
Binuclearia
Bohlinia
Botryococcus
Brachiomonas

Carteria
Cephalmonas
Cerasterias
Chaetophora
Characium
Chlamydomonas
Chlorella
Chlorochytrium
Chlorococcum
Chlorogonium
Chloromonas
Chlorosarcina
Chodatella
Cladophora
Closteridium
Closteriopsis
Closterium
Coccomonas
Coelastrum
Coleochaete
Coronastrum
Cosmarium
Cosmocladium
Crucigenia
Cylindrocapsa
Cylindrocystis

Dactylococcus
Dactylothece
Desmatractum
Desmidium
Dichotomococcus
Dictyosphaerium
Dimorphococcus
Dispora
Dunaliella
Dysmorphococcus

Echinosphaerella
Elakatothrix
Eremosphaera
Errerella
Euastropsis
Euastrum
Eudorina
Eutetramorus

Franceia
Fridaea

Geminella
Gloeoactinium
Gloeocystis
Golenkinia
Golenkiniopsis
Gonatozygon
Gonium

Haematococcus
Heteromastix
Hormidium
Hormotila
Hyalotheca

Hydrodictyon

Kirchneriella

Lobomonas

Mesostigma
Mesotaenium
Micractinium
Micrasterias
Microspora
Mougeotia
Mougeotiopsis

Nannochloris
Nephrocytium
Netrium

Oedogonium
Onychonema
Oocystis
Ourococcus

Pachycladon
Palmella
Palmellococcus
Palmodictyon
Pandorina
Pediastrum
Penium
Phacotus
Phyllobium
Phymatodocis
Planktosphaeria
Platydorina
Platymonas
Pleodorina
Pleurotaenium
Polyedriopsis
Polytoma
Protococcus
Protosiphon
Pteromonas
Pyramimonas
Pyrobotrys

Quadricoccus
Quadrigula

Radiococcus
Raphidonema
Rhizoclonium
Rhodochytrium
Roya

Scenedesmus
Schizochlamys
Schroederia
Selenastrum
Sorastrum
Spermatozoopsis
Sphaerellopsis
Sphaerocystis
Sphaerozosma
Spirogyra
Spondylomorum
Spondylosium
Staurastrum
Stichococcus
Stigeoclonium
Stylosphaeridium

Tetmemorus
Tetradesmus
Tetraedron
Tetrallantos
Tetraspora
Tetrastrum
Thoracomonas
Trebouxia
Treubaria
Trochiscia

Ulothrix
Uronema

Volvox

Westella
Wislouchiella

Xanthidium

Zygnema
Zygnemopsis

EUGLENOPHYTA (Euglenoids)

Astasia
Calcycimonas
Colacium
Cryptoglena
Distigma
Euglena
Euglenopsis
Eutreptia
Lepocinclis
Menoidium
Phacus
Protochrysis
Strombomonas
Trachelomonas

TABLE 1.—*List of algal genera observed in the phytoplankton of the United States*—Continued

CHRYSOPHYTA

Chrysophytes

Amphichrysis
Botrydiopsis
Bumilleriopsis
Centritractus
Characiopsis
Chlorallanthus
Chlorellidiopsis
Chlorobotrys
Chlorocloster
Chromulina
Chrysamoeba
Chrysochromulina
Chrysococcus
Chrysosphaerella
Chrysoxys
Cyclonexis
Diachros
Diceras
Dinobryon
Epipyxis
Gloeochloris
Harpochytrium
Hydrurus
Kephyrion
Mallomonas
Mischococcus
Ochromonas
Olisthodiscus
Ophiocytium
Perone
Peroniella
Pseudokephyrion
Rhizochrysis
Stipitococcus
Synura
Tribonema
Uroglena
Uroglenopsis

CHRYSOPHYTA

Diatoms

Achnanthes
Actinella
Actinocyclus
Amphicampa
Amphipleura
Amphora
Anomoeoneis
Asterionella
Attheya
Auliscus
Biddulphia
Caloneis
Campylodiscus
Cerataulina
Chaetoceros
Cocconeis
Coscinodiscus
Cyclotella
Cylindrotheca
Cymbella
Denticula
Diatoma
Diatomella
Diploneis
Entomoneis
Epithemia
Eunotia
Fragilaria
Frustulia
Gomphoneis
Gomphonema
Guinardia
Gyrosigma
Hannaea
Hantzschia
Hemiaulus
Hyalodiscus
Licmophora
Mastogloia
Melosira
Meridion
Navicula
Neidium
Nitzschia
Opephora
Pinnularia
Plagiotropsis
Pleurosigma
Rhabdonema
Rhizosolenia
Rhoicosphenia
Rhapalodia
Scoliopleura
Skeletonema
Stauroneis
Stephanodiscus
Stephanopyxis
Streptotheca
Surirella
Synedra
Tabellaria
Terpsinoe
Tetracyclus
Thalassiosira

PHYRROPHYTA (Dinoflagellates)

Amphidinium
Ceratium
Dinophysis
Exuviaella
Glenodinium
Gonyaulax
Gymnodinium
Gyrodinium
Hemidinium
Massartia
Oxyphysis
Peridinium
Prorocentrum

CRYPTOPHYTA (Cryptomonads)

Chilomonas
Chroomonas
Cryptomonas
Cyanomonas
Rhodomonas

TABLE 1.—*List of algal genera observed in the phytoplankton of the United States*—Continued

CYANOPHYTA (Blue-green algae)		
Agmenellum	*Gloeocapsa*	*Nostoc*
Anabaena	*Gloeotrichia*	
Anabaenopsis	*Gomphosphaeria*	*Oscillatoria*
Anacystis		
Aphanizomenon	*Hydrocoleum*	*Phormidium*
Arthrospira		*Plectonema*
	Isocystis	*Porphyrosiphon*
Borzia		
	Johannesbaptistia	*Raphidiopsis*
Calothrix		*Rivularia*
Coccochloris	*Kyrkia*	
Cylindrospermum		*Schizothrix*
	Lyngbya	*Spirulina*
Dactylococcopsis		*Symploca*
	Microcoleus	
Entophysalis		*Tetrapedia*
	Nodularia	*Trichodesmium*

RHODOPHYTA (Red algae)	
Audouinella	*Bangia*

TABLE 2.—*Commonly occurring genera of algae observed in the phytoplankton of the United States*

Genus	Number of occurrence[1]	Percent
Nitzschia	13,480	75
Navicula	12,374	69
Cyclotella	11,161	62
Scenedesmus	8,580	48
Ankistrodesmus	8,161	45
Melosira	7,446	41
Synedra	7,001	39
Gomphonema	6,519	36
Anacystis	5,852	33
Oscillatoria	5,556	31
Achnanthes	4,962	28
Cymbella	4,938	27
Chlamydomonas	4,649	26
Cocconeis	4,182	23
Diatoma	3,906	22
Trachelomonas	3,625	20
Fragilaria	3,255	18
Surirella	2,984	17
Euglena	2,763	15
Kirchneriella	2,580	14
Asterionella	2,538	14
Oocystis	2,518	14
Dictyosphaerium	2,446	14
Crucigenia	2,289	13
Cryptomonas	2,226	12
Anabaena	2,164	12
Lyngbya	2,080	12
Rhoicosphenia	1,952	11
Agmenellum	1,849	10
Tetraedron	1,793	10

TABLE 2.—*Commonly occurring genera of algae observed in the phytoplankton of the United States*—Continued

Genus	Number of occurrence[1]	Percent
Actinastrum	1,672	9
Pediastrum	1,611	9
Micractinium	1,499	8
Schroederia	1,413	8
Amphora	1,409	8
Tetrastrum	1,315	7
Gyrosigma	1,288	7
Epithemia	1,261	7
Coelastrum	1,250	7
Dinobryon	1,247	7
Pinnularia	1,230	7
Selenastrum	1,222	7
Aphanizomenon	1,127	6
Stephanodiscus	1,092	6
Chroomonas	1,027	6
Glenodinium	962	5
Peridinium	950	5
Eunotia	879	5
Chodatella	852	5
Golenkinia	847	5
Cosmarium	817	5

[1] Based on 17,959 samples.

TABLE 3.—*Dominant genera*[1] *of algae observed in the phytoplankton of the United States*

Genus	Number of dominances[2]	Percent
Nitzschia	3,530	20
Oscillatoria	3,402	19
Cyclotella	3,362	19
Navicula	3,361	19
Anacystis	2,696	15
Melosira	2,388	13
Scenedesmus	1,831	10
Lyngbya	1,091	6
Synedra	734	4
Achnanthes	732	4
Agmenellum	701	4
Anabaena	691	4
Gomphonema	685	4
Fragilaria	679	4
Asterionella	543	3
Ankistrodesmus	536	3
Aphanizomenon	520	3
Diatoma	429	2
Chlamydomonas	375	2
Dictyosphaerium	372	2
Cymbella	327	2
Cocconeis	306	2
Crucigenia	280	2
Gomphosphaeria	266	[3]2

TABLE 3.—*Dominant genera*[1] *of algae observed in the phytoplankton of the United States*—Continued

Genus	Number of dominances[2]	Percent
Trachelomonas	210	1
Coelastrum	209	1
Actinastrum	179	1
Pediastrum	171	1
Micractinium	170	<1
Cryptomonas	145	<1
Oocystis	145	<1
Dinobryon	144	<1
Sphaerocystis	144	[3]<1
Surirella	126	<1
Cylindrospermum	124	[3]<1
Chroomonas	120	<1
Pandorina	103	[3]<1
Euglena	97	<1
Phormidium	92	[3]<1
Eunotia	91	<1
Raphidiopsis	91	[3]<1
Kirchneriella	79	<1

[1] Comprising 15 percent or more of sample.
[2] Based on 17,959 samples
[3] Not a commonly occurring genus (see table 2).

TABLE 4.—*Taxonomic groupings of commonly occurring and dominant genera of algae of the United States*

CHLOROPHYTA (Green algae)		
Actinastrum	*Dictyosphaerium*	*Scenedesmus*
Ankistrodesmus	*Golenkinia*	*Schroederia*
Chlamydomonas	*Kirchneriella*	*Selenastrum*
Chodatella	*Micractinium*	*Sphaerocystis*
Coelastrum	*Oocystis*	*Tetraedron*
Cosmarium	*Pandorina*	*Tetrastrum*
Crucigenia	*Pediastrum*	
EUGLENOPHYTA (Euglenoids)		
Euglena	*Trachelomonas*	
CHRYSOPHYTA (Chrysophytes and diatoms)		
Achnanthes	*Epithemia*	*Nitzschia*
Amphora	*Eunotia*	*Pinnularia*
Asterionella	*Fragilaria*	*Rhoicosphenia*
Cocconeis	*Gomphonema*	*Stephanodiscus*
Cyclotella	*Gyrosigma*	*Surirella*
Cymbella	*Melosira*	*Synedra*
Diatoma	*Navicula*	*Tabellaria*
Dinobryon		
PYRROPHYTA (Dinoflagellates)		
Glenodinium	*Peridinium*	
CRYPTOPHYTA (Cryptomonads)		
Chroomonas	*Cryptomonas*	
CYANOPHYTA (Blue-green algae)		
Agmenellum	*Cylindrospermum*	*Oscillatoria*
Anabaena	*Gomphosphaeria*	*Phormidium*
Anacystis	*Lyngbya*	*Raphidiopsis*
Aphanizomenon		

TAXONOMIC KEY TO THE IDENTIFICATION OF COMMONLY OCCURRING AND DOMINANT GENERA OF ALGAE OBSERVED IN THE PHYTOPLANKTON OF THE UNITED STATES

[The following key consists of couplets of characteristics. One must decide which statement of the couplet most accurately describes the specimen. Having made a selection, proceed to the couplet indicated by the number to the right. Continue through the key until a genus is indicated. The key is constructed for the 58 genera described in this report. The identification of other genera requires the use of a more comprehensive key.]

1A Plant pigments contained in chromatophores or chloroplasts ---------- 10

1B Plant pigments not contained in chromatophores or chloroplasts, but diffused through protoplast ---------- 2

2A Plants filamentous; cells arranged in trichomes ---------- 4

2B Plants colonial, not filamentous ---------- 3

3A Cells in regular rows, generally in multiples of four; colony one cell in thickness ---------- *Agmenellum*

3B Cells somewhat evenly arranged toward periphery of spherical colony; barely visible gelatinous strands radiate from center of colony to cells ---------- *Gomphosphaeria*

3C Colony asymmetrical; cells very dense and unevenly distributed ---------- *Anacystis*

4A Filaments straight or slightly flexed ---------- 6

4B Filaments curved, twisted, or spiraled ---------- 5

5A Heterocysts and akinetes present ---------- *Anabaena*

5B Heterocysts absent ---------- *Raphidiopsis*

6A Heterocysts present ---------- 9

6B Heterocysts absent ---------- 7

7A Filaments without a sheath; cells discoid ---------- *Oscillatoria*

7B Filaments with distinct sheath ---------- 8

8A Trichomes tangled; sheaths confluent ---------- *Phormidium*

8B Trichomes separate; sheaths not confluent ---------- *Lyngbya*

9A Heterocysts terminal ---- *Cylindrospermum*
9B Heterocysts intercalary ---- *Ahphanizomenon*
10A Cell walls without punctae or striae ---- 31
10B Cell walls rigid, ornamented with punctae or striae, indestructible by clearing techniques ---- 11
11A Frustules adiametric, two or more times longer than wide, generally elongate ---- 15
11B Frustules isodiametric, generally shorter in length than in diameter, round or elliptical or ovoid or nearly so ---- 12
12A Frustules elliptical or ovoid or nearly so ---- 14
12B Frustules discoid or nearly so ---- 13
13A Valves radially punctate ---- *Stephanodiscus*
13B Valves with two concentric regions, the inner being smooth ---- *Cyclotella*
14A Frustules with marginal keel containing a raphe ---- *Surirella*
14B Frustules with a pseudoraphe or with a raphe not in a marginal keel ---- *Cocconeis*
15A Frustules cylindrical arranged end to end into filament ---- *Melosira*
15B Frustules not arranged into filaments ---- 16
16A Frustules with a raphe in at least one valve ---- 21
16B Frustules without a raphe in either valve, pseudoraphe evident ---- 17
17A Frustules united in zigzag chains ---- *Tabellaria*
17B Frustules not in zigzag chains ---- 18
18A Frustules united laterally ---- *Fragilaria*
18B Frustules not united laterally ---- 19
19A Frustules united apically forming spokelike colony ---- *Asterionella*
19B Frustules not forming spokelike colony ---- 20
20A Frustules needle shaped without costae ---- *Synedra*
20B Frustules with prominant costae ---- *Diatoma*

21A Frustules sigmoid or "S" shaped ---------- *Gyrosigma*
21B Frustules not sigmoid ---------- 22
22A Frustules longitudinally symmetrical, other than lunate in valve view ---------- 25
22B Frustules with raphe in both valves, longitudinally asymmetrical, lunate in valve view ---------- 23
23A Valves with transverse costae ---------- *Epithemia*
23B Valves without transverse costae ---------- 24
24A Raphe a smooth curve with well defined central and polar nodules ---------- *Cymbella*
24B Raphe not a smooth curve, gibbose with marginal central nodule ---------- *Amphora*
25A Frustules with raphe in both valves ---------- 27
25B Frustules with pseudoraphe in one valve and raphe in other valve ---------- 26
26A Frustules wedge-shaped in girdle view and cuneate in valve view ---------- *Rhoicosphenia*
26B Frustules shaped otherwise ---------- *Achnanthes*
27A Raphe extended length of valve; polar nodules evident; central nodules lacking ---------- *Eunotia*
27B Raphe restricted to polar regions ---------- 28
28A Raphe located in a canal ---------- *Nitzschia*
28B Raphe not located in a canal ---------- 29
29A Frustules with symmetrical valves ---------- 30
29B Frustules with valves longitudinally symmetrical but transversely asymmetrical ---------- *Gomphonema*
30A Valves with transverse costae ---------- *Pinnularia*
30B Valves with transverse punctae ---------- *Navicula*
31A Cells solitary ---------- 45
31B Cells colonial or grouped ---------- 32
32A Cells enclosed in conical to cylindrical lorica; joined lorica have treelike appearance ---------- *Dinobryon*

32B Cells and lorica without treelike appearance ---- 33
33A Colony discoid, one cell in thickness; cells in concentric rings ---- *Pediastrum*
33B Colony not discoid ---- 34
34A Colonies spherical or globose ---- 40
34B Colonies not spherical ---- 35
35A Colony with elongate cells radiating from common center ---- *Actinastrum*
35B Colony with cells not radiating from common center ---- 36
36A Colony with (generally) four to eight cells positioned in linear series ---- *Scenedesmus*
36B Colony with cells not in linear series ---- 37
37A Colony with arcuate to lunate cells with apices acutely pointed; convex faces of cells apposed ---- *Selenastrum*
37B Colony with spherical to broadly ellipsoidal cells ---- 38
38A Cells without spines or setae ---- *Crucigenia*
38B Cells with spines or setae ---- 39
39A Cells quadrate, closely apposed; free face of each cell with one or more spines ---- *Tetrastrum*
39B Cells quadrate and united; free face of each cell with two to seven long delicate setae ---- *Micractinium*
40A Colony with biflagellated cells ---- *Pandorina*
40B Colony with nonflagellated cells ---- 41
41A Cells lunate to sickle shaped ---- *Kirchneriella*
41B Cells spherical or nearly so ---- 42
42A Cells borne terminally on dichotomously branched threads ---- *Dictyosphaerium*
42B Cells not on dichotomously branched threads ---- 43
43A Colony a hollow sphere ---- *Coelastrum*
43B Colony not a hollow sphere ---- 44
44A Colony surrounded by partially gelatinized and greatly expanded parent cell wall ---- *Oocystis*

44B Colony with cells equidistant and toward periphery ——— *Sphaerocystis*
45A Cells with median constriction dividing cell into two distinct halves ——— *Cosmarium*
45B Cells without pronounced median constriction ——— 46
46A Cells nonflagellated ——— 53
46B Cells flagellated ——— 47
47A Cell walls without polygonal plates ——— 49
47B Cell walls with polygonal plates ——— 48
48A Cells walls of thick plates with distinct sutures ——— *Peridinium*
48B Cells walls with faintly distinct plates and sutures ——— *Glenodinium*
49A Cells uniflagellate ——— 52
49B Cells biflagellate ——— 50
50A Cells with two flagella of equal length ——— *Chlamydomonas*
50B Cells with two flagella of unequal length ——— 51
51A Cells with single chromatophore ——— *Chroomonas*
51B Cells with 2 large chromatophores ——— *Cryptomonas*
52A Cells surrounded by distinct lorica ——— *Trachelomonas*
52B Cells without lorica; fusiform to acicular shaped; posterior end more or less pointed ——— *Euglena*
53A Cells acicular to fusiform with ends tapering into long spines ——— *Schroederia*
53B Cells without ends tapering into long spines ——— 54
54A Cells without setae ——— 56
54B Cells with setae ——— 55
55A Cells with subpolar or both subpolar and equatorial long setae ——— *Chodatella*
55B Cells with multiple peripheral long delicate setae ——— *Golenkinia*
56A Cells long, slender, and tapered at both ends ——— *Ankistrodesmus*
56B Cells flattened or isodiametric, triangular, quadrangular, or polygonal ——— *Tetraedron*

DESCRIPTION OF THE GENERA

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Scenedesmaceae
GENUS *ACTINASTRUM* Lagerheim, 1882 (fig. 1)

MORPHOLOGY

Cells are ovoid, oblong, or club shaped and radiate from a common center. Cell diameter ranges from about 1 to 6 μm, and cell length varies from about 10 to 35 μm. Chromatophores are parietal. Coenobia generally contain 4, 8, or 16 cells.

REPRODUCTION

The protoplast is divided into 4, 8, or 16 autospores by transverse and longitudinal division. The daughter cells, joined in fasciculate bundles, are released following rupture of the parent-cell wall. Following release, the cells separate outwardly from the point where the cells touch.

OCCURRENCE

Actinastrum is widely distributed in the euplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	20.8	7.6
pH	5.7 – 9.6	7.8	.6
Dissolved oxygen, milligrams per liter	.8 – 19.7	8.6	2.3
Specific conductance, micromho	10 –49,800	958	2,210
Total alkalinity, milligrams per liter	3 – 440	138	78
Total hardness, do	6 – 1,800	253	250
Total nitrogen, do	.01– 17.0	1.80	1.83
Total phosphorus, do	.0 – 3.5	.2	.3

SPECIES INFORMATION

Refer to Smith (1920) and Prescott (1962).

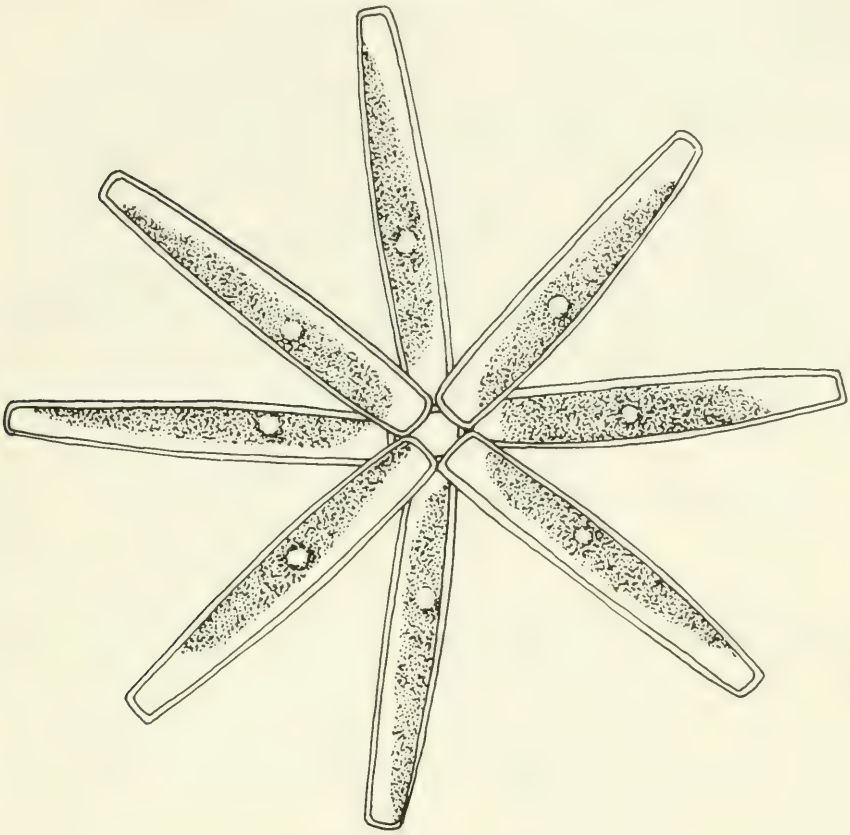

FIGURE 1.—Drawing of *Actinastrum*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Oocystaceae
GENUS *ANKISTRODESMUS* Corda, 1838; emend., Ralfs, 1848 (fig. 2)

MORPHOLOGY

Cells are acicular to fusiform, straight, curved, or sigmoid. Diameter ranges from about 1 to 4 μm; cells length varies from 15 to 80 μm. Cells are generally singular but may be loosely aggregated. The single chromatophore is parietal.

REPRODUCTION

The cell divides longitudinally into 2, 4, or 8 autospores.

OCCURRENCE

Ankistrodesmus is widely distributed in the euplankton, but it rarely occurs in abundance. According to Smith (1950), aquariums and other receptacles containing water that has been standing in the laboratory for some time may contain a virtually unialgal culture of the alga. The commonly occurring species, *Ankistrodesmus falcatus*, is generally found in acidic water of high temperature, where there is a dense conglomeration of other algae.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature_____degrees Celsius__	0.0 - 36.0	17.4	8.6
pH_____	3.4 - 10.0	7.6	.7
Dissolved oxygen_____milligrams per liter__	.1 - 22.0	8.9	2.5
Specific conductance _____micromho__	10 -50,000	857	1,881
Total alkalinity _____milligrams per liter__	0 - 500	116	83
Total hardness _____do_____	3 - 2,000	217	258
Total nitrogen _____do_____	.00- 41.0	1.54	1.80
Total phosphorus _____do_____	.0 - 3.9	.2	.3

SPECIES INFORMATION

Refer to Brunnthaler (1915) and Prescott (1962).

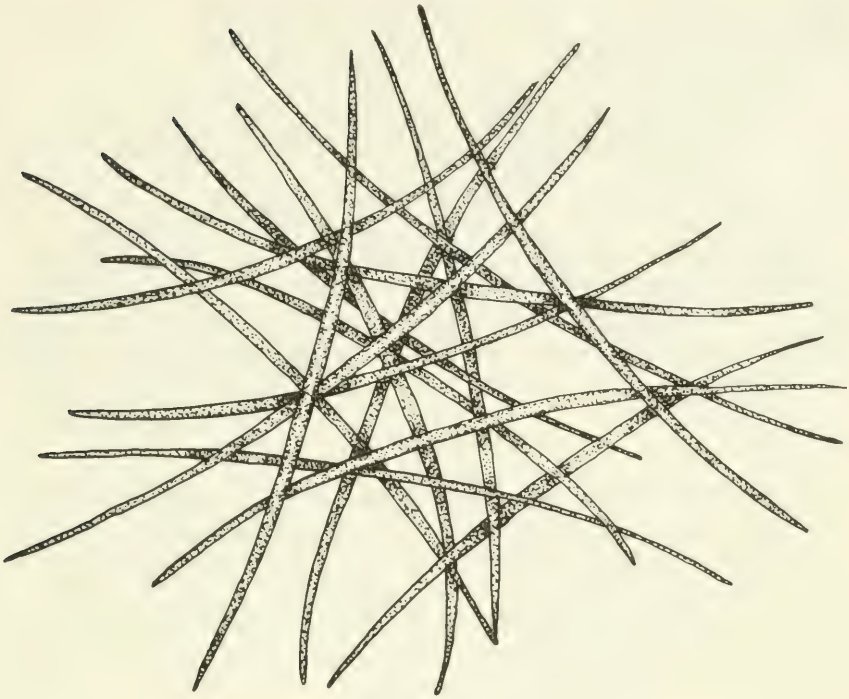

FIGURE 2.–Drawing of *Ankistrodesmus*.

Division Chlorophyta
Class Chlorophyceae
Order Volvocales
Family Chlamydomonadaceae
GENUS *CHLAMYDOMONAS* Ehrenberg, 1833 (fig. 3)

MORPHOLOGY

Actively motile solitary cells are ovoid, spherical, fusiform, or ellipsoidal and range from 3 to 10 μm in diameter. Two equal-lengthed flagella are located at the anterior end. Cell contains a single, cup-shaped chromatophore and contractile vacuoles. Eyespot may or may not be present.

REPRODUCTION

The alga reproduces both asexually and sexually. Asexual reproduction is by longitudinal division into 2, 4, or 8 daughter cells, which are enveloped in an amorphous gelatinous wall. Continued division results in the palmella stage. Cells develop flagella and escape through the parent-cell wall. Species may be homothallic or heterothallic, and gametic union may be isogamous, anisogamous, oogamous.

OCCURRENCE

The alga occurs commonly in the euplankton and tychoplankton as solitary, free-swimming cells. It has a widespread distribution, but generally it is found in calm or very slowly moving waters.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.5	16.8	8.9
pH	4.1 – 9.8	7.7	.7
Dissolved oxygen, milligrams per liter	.1 – 22.0	9.0	2.6
Specific conductance, micromho	10 –49,800	1,185	3,250
Total alkalinity, milligrams per liter	0 – 500	132	85
Total hardness, do	3 – 2,000	252	289
Total nitrogen, do	.00– 26.0	1.65	1.86
Total phosphorus, do	.0 – 4.0	.2	.4

SPECIES INFORMATION

Refer to Pascher (1927), Gerloff (1940), and Prescott (1962).

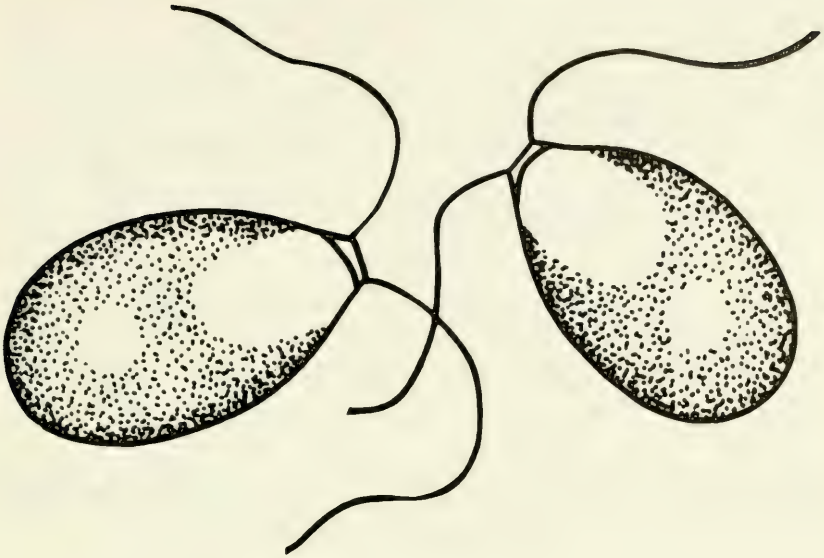

FIGURE 3.—Drawing of *Chlamydomonas*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Oocystaceae

GENUS *CHODATELLA* Lemmermann, 1898 (fig. 4)

Generic synonym.—*Lagerheimia* Chodat, 1895.

MORPHOLOGY

Solitary cells are citriform, ellipsoidal, subcylindrical, or subspherical and contain long setae that are subpolar, or subpolar and equatorial, in insertion. One to four laminate to discoid chromatophores are present.

REPRODUCTION

Cells divide into 2, 4, or 8 autospores, which are released simultaneously from the parent-cell wall. Setae develop after release.

OCCURRENCE

Solitary, free-floating cells are found commonly in the euplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	19.0	8.2
pH	5.6 – 9.5	7.8	.6
Dissolved oxygen, milligrams per liter	.1 – 20.6	9.0	2.4
Specific conductance, micromho	11 –21,500	972	1,700
Total alkalinity, milligrams per liter	3 – 440	129	78
Total hardness, do	5 – 1,800	249	254
Total nitrogen, do	.05– 26.0	1.66	1.92
Total phosphorus, do	.0 – 3.7	.2	.4

SPECIES INFORMATION

Refer to Smith (1920, 1926) and Prescott (1962).

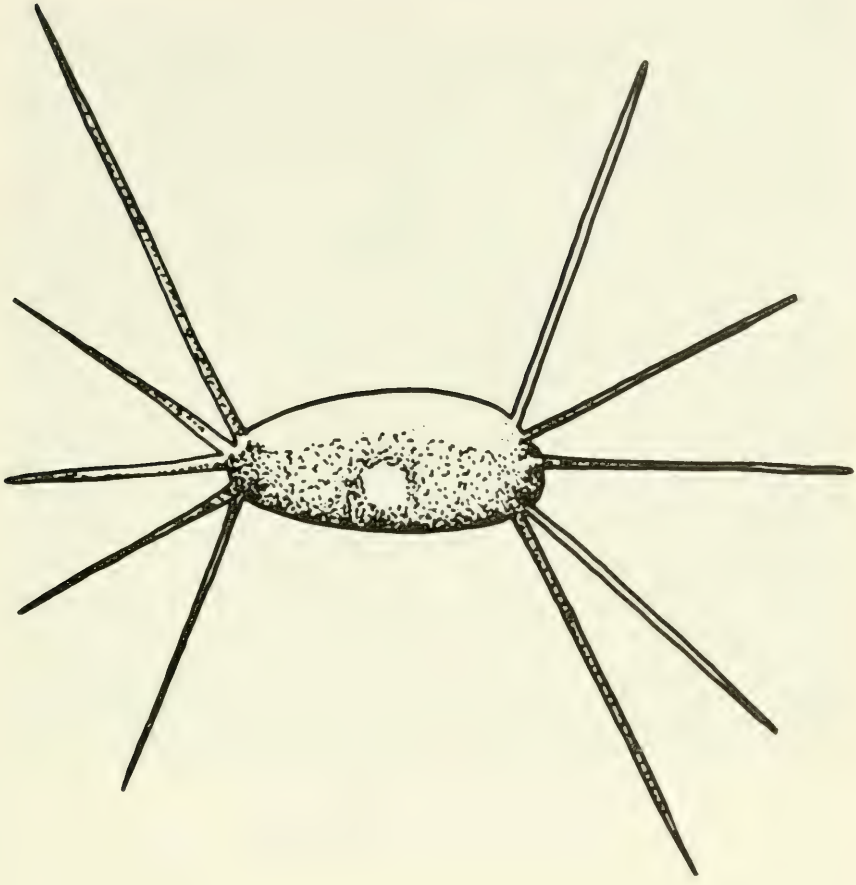

FIGURE 4.—Drawing of *Chodatella*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Coelastraceae
GENUS *COELASTRUM* Nägeli, 1849 (fig. 5)

MORPHOLOGY

Cells are spherical, ovoid, or pyramidal and range from 3 to 25 μm in diameter. Chromatophores are cup shaped to diffuse. Coenobia generally are hollow spheres consisting of 4, 8, 16, 32, 64, or 128 cells connected by processes of varying length. Sheath is very delicate.

REPRODUCTION

One or more cells in the colony divides into 4, 8, 16, 32, 64, or 128 autospores that remain united. The newly formed colony is released by bipartition or quadripartition of the parent-cell wall (Crow, 1925). Occasionally, a cell develops into an aplanospore, which is released prior to division into a new colony.

OCCURRENCE

The genus is widely distributed in slowly moving waters. It is an insignificant component of algal communities indicating eutrophic conditions. It often is found sparingly intermingled with other algae in pools and ditches (Smith, 1950).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	22.2	6.0
pH	4.2 – 9.4	7.7	.6
Dissolved oxygen, milligrams per liter	.4 – 19.7	8.1	2.2
Specific conductance, micromho	10 –35,500	808	1,660
Total alkalinity, milligrams per liter	0 – 390	120	71
Total hardness, do	6 – 1,400	212	200
Total nitrogen, do	.07– 19.0	1.67	1.90
Total phosphorus, do	.0 – 3.4	.2	.3

SPECIES INFORMATION

Refer to Ducellier (1915), Brunnthaler (1915), and Prescott (1962).

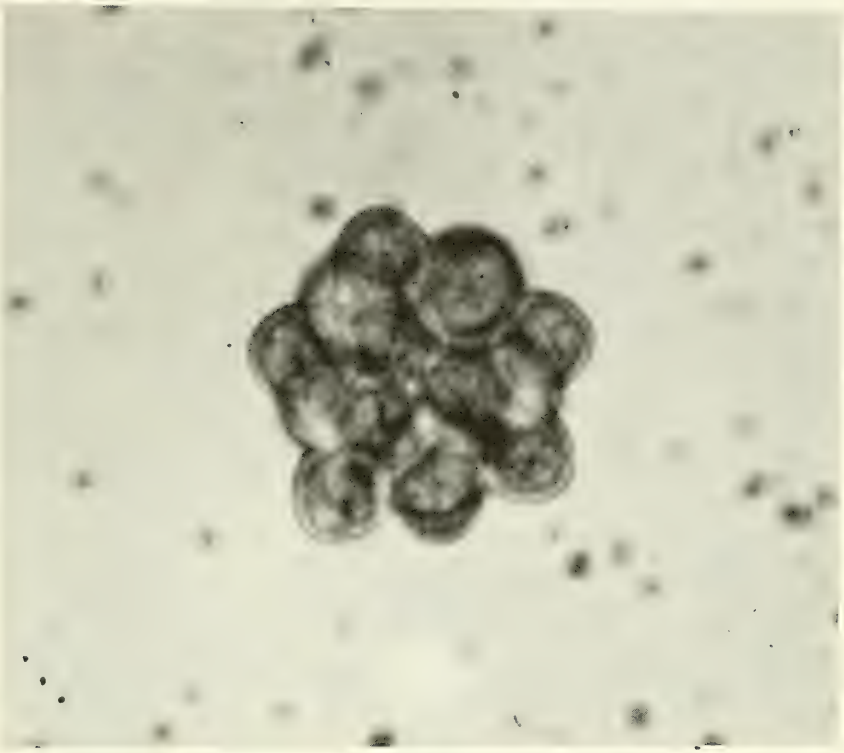

FIGURE 5. – Photomicrograph of *Coelastrum*.

Division Chlorophyta.
Class Chlorophyceae
Order Zygnematales
Family Desmidiaceae
GENUS *COSMARIUM* Corda, 1834 (fig. 6)

MORPHOLOGY

Cells are variable in size, ranging from 9 to 100 μm in diameter and generally are longer than wide. Semicells are elliptical, semicircular, subquadrate, or pyramidal. The apex is rounded, truncate, or subtruncate, without an apical incision. A single, axial chromatophore is located in each semicell. The genus is solitary.

REPRODUCTION

During sexual reproduction, the protoplasts of 2 conjugating cells emerge at each isthmus, unite, and form a zygote. Each zygote develops into 2 daughter cells, each of which develops a cell wall before being released by rupture of the zygotic wall.

OCCURRENCE

There are many species in the genus, which has widespread distribution.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	21.0	7.2
pH	5.2 – 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	.7 – 20.6	8.3	2.3
Specific conductance, micromho	10 –18,000	529	1,150
Total alkalinity, milligrams per liter	2 – 430	89	70
Total hardness, do	6 – 1,200	146	153
Total nitrogen, do	.09– 32.0	1.31	2.11
Total phosphorus, do	.0 – 2.0	.1	.2

SPECIES INFORMATION

Refer to West and West (1905, 1908, 1912).

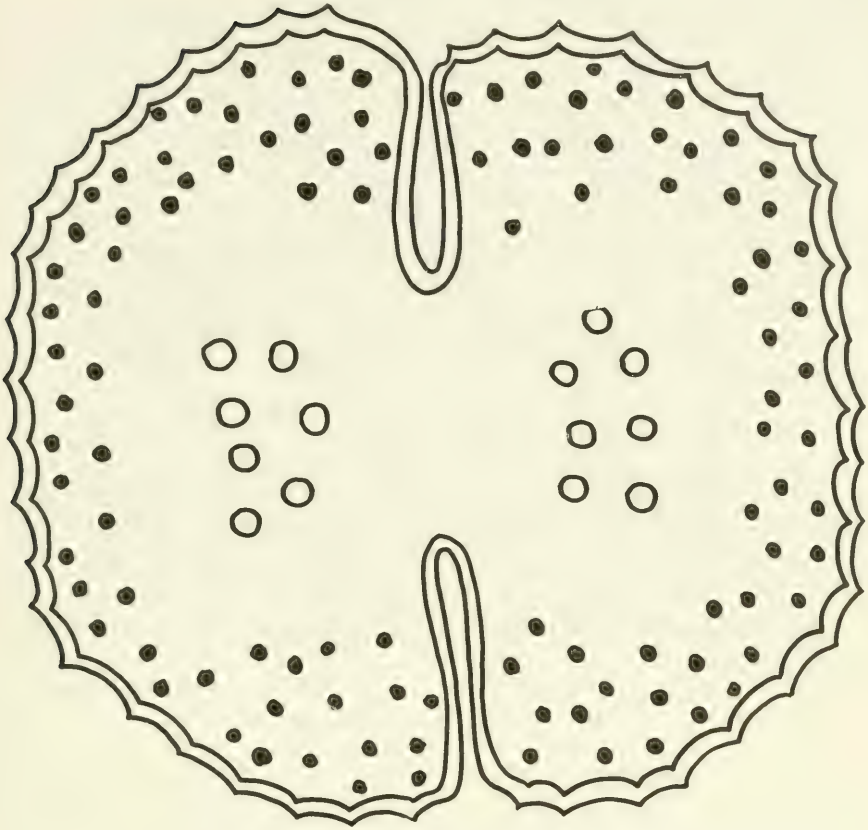

FIGURE 6. – Drawing of *Cosmarium*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Scenedesmaceae
GENUS *CRUCIGENIA* Morren, 1830 (fig. 7)

MORPHOLOGY

Cells, 4–10 μm in diameter, are elliptical, triangular, trapezoidal, or semicircular in surface view. One to 4 cup-shaped chromatophores are situated parietally in each cell. Cells are joined quadrately to form a 4-celled coenobia. Several coenobia may be enclosed in a gelatinous envelope.

REPRODUCTION

The protoplast divides into 4 autospores that remain quadrately apposed.

OCCURRENCE

Free-floating colonies occur commonly in the euplankton. It is widely distributed.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	19.6	8.0
pH	4.7 – 9.6	7.6	.7
Dissolved oxygen, milligrams per liter	.5 – 22.0	8.5	2.4
Specific conductance, micromho	10 –45,500	716	1,540
Total alkalinity, milligrams per liter	0 – 440	116	85
Total hardness, do	5 – 1,700	192	196
Total nitrogen, do	.03– 20.0	1.46	1.56
Total phosphorus, do	.0 – 3.9	.2	.3

SPECIES INFORMATION

Refer to Smith (1920, 1926) and Prescott (1962).

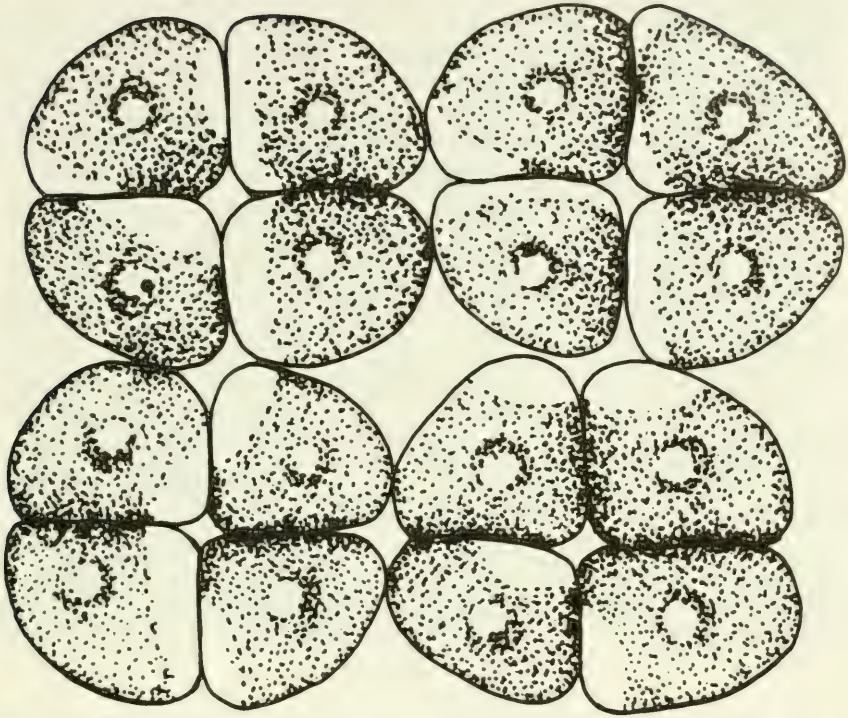

FIGURE 7. – Drawing of *Crucigenia*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Oocystaceae
GENUS *DICTYOSPHAERIUM* Nägeli, 1849 (fig. 8)

MORPHOLOGY

Cells are spherical, ovoid, ellipsoidal, or reniform and range from 3 to 10 μm in diameter. Each cell contains a single, cup-shaped, parietal chromatophore. Cells are connected by branching threads. Colony is embedded in a copious, homogeneous, gelatinous sheath.

REPRODUCTION

Antherozoids (generally 16 or 32) from a male colony swarm around one of 2 eggs released by a female colony. An antherozoid and an egg become laterally fused to form a zygote. Division of the zygote forms a daughter colony. Asexual reproduction of a cell into 2 to 4 autospores precedes the movement of the daughter cells to the tips of segments formed by the partial splitting of the parent-cell wall.

OCCURRENCE

The alga is of widespread distribution. It is found most often in soft to semihard waters.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	20.0	7.6
pH	4.6 – 9.6	7.6	.7
Dissolved oxygen, milligrams per liter	.1 – 19.7	8.5	2.3
Specific conductance, micromho	10 –50,000	814	1,860
Total alkalinity, milligrams per liter	0 – 440	112	80
Total hardness, do	5 – 1,900	206	232
Total nitrogen, do	.00– 19.0	1.49	1.55
Total phosphorus, do	.0 – 2.9	.2	.3

SPECIES INFORMATION

Refer to Tiffany (1934), Smith (1920), and Prescott (1962).

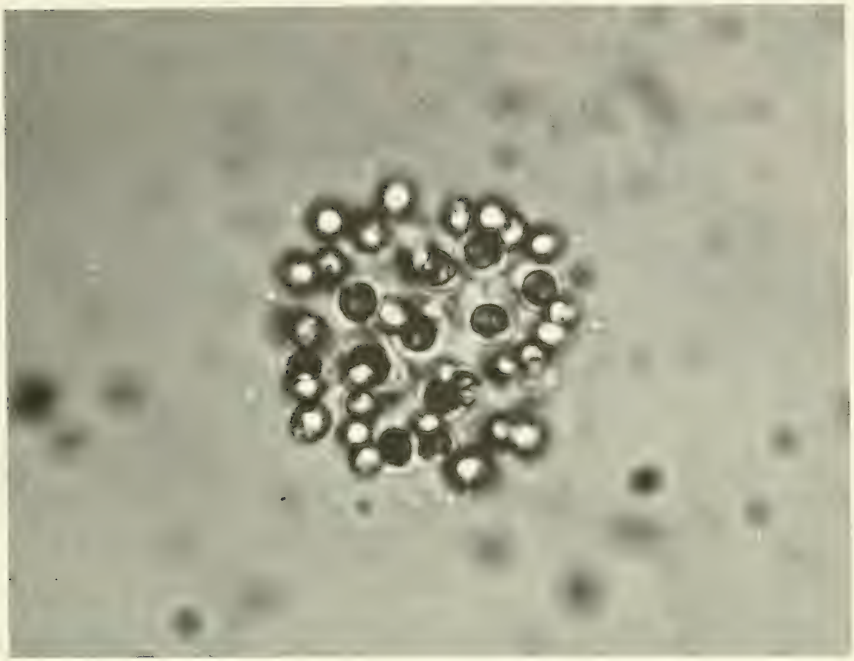

FIGURE 8. – Photomicrograph of *Dictyosphaerium*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Micractiniaceae
GENUS *GOLENKINIA* Chodat, 1894 (fig. 9)

MORPHOLOGY

Solitary cells, 7-15 μm in diameter, contain numerous, long, slightly tapering setae. The single chromatophore is parietal and cup shaped.

REPRODUCTION

Two, 4, or 8 autospores are formed and released by fragmentation of the parent-cell wall. Sexual reproduction is oogamous. Biflagellate antherozoids swarm around a cell containing a single egg, a part of which protrudes through the cell wall. After fusion, the zygote moves through the pore and becomes attached to the parent-cell wall.

OCCURRENCE

Golenkinia is common in the euplankton. It is present generally in shallow, slow-moving waters.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature_____degrees Celsius__	0.0 - 35.9	19.9	8.1
pH_____	5.5 - 9.6	7.7	.7
Dissolved oxygen_____milligrams per liter__	.1 - 19.7	8.8	2.5
Specific conductance _____micromho__	10 -12,000	688	1,060
Total alkalinity _____milligrams per liter__	6 - 440	114	78
Total hardness _____do_____	7 - 1,500	201	199
Total nitrogen _____do_____	.9 - 15.0	1.61	.09
Total phosphorus _____do_____	.0 - 3.5	.2	.3

SPECIES INFORMATION

Refer to Tiffany (1934), Smith (1920), and Prescott (1962).

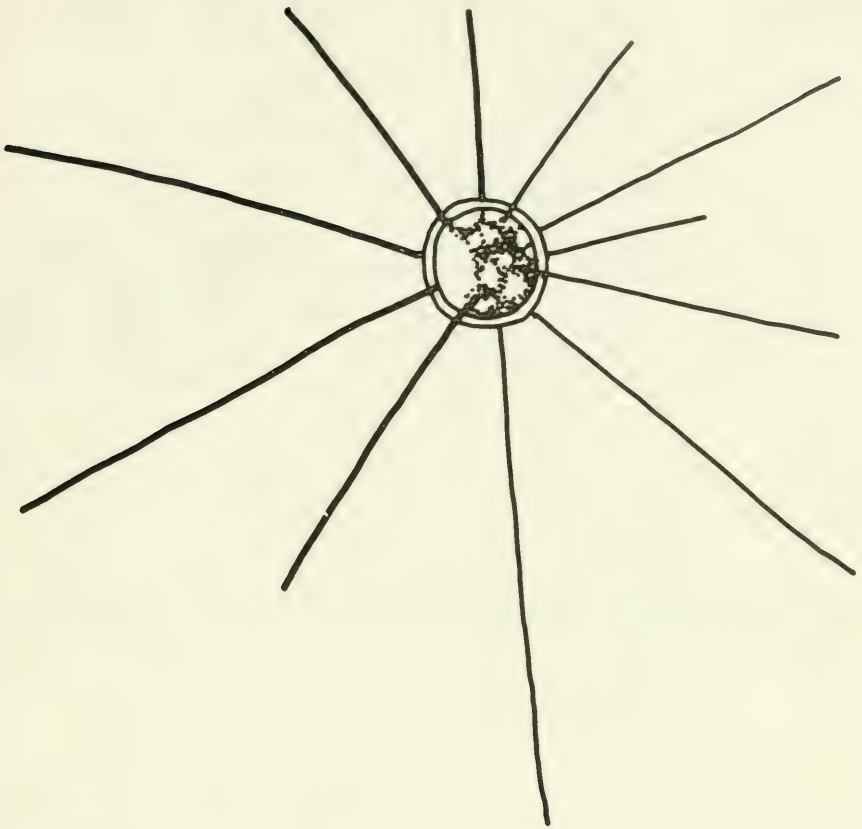

FIGURE 9.—Drawing of *Golenkinia*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Oocystaceae
GENUS *KIRCHNERIELLA* Schmidle, 1893 (fig. 10)

MORPHOLOGY

Cells are generally acute or lunate and attenuated. Cell apices are often in close proximity. A single chromatophore is parietal on convex side of cell or entirely fills the cells. Cells are arranged loosely in groups of 4 or 8 within a wide gelatinous envelope. Colony may be as much as 250 μm in diameter.

REPRODUCTION

Cellular division results in 4 to 8 autospores that separate as the parent-cell wall gelatinizes.

OCCURRENCE

The genus rarely occurs in great numbers and often is found intermingled among other algae. It generally is indicative of acidic conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 - 36.0	20.0	7.9
pH	3.7 - 9.8	7.7	.7
Dissolved oxygen, milligrams per liter	.1 - 22.0	8.6	2.5
Specific conductance, micromho	10 - 48,000	918	2,350
Total alkalinity, milligrams per liter	6 - 470	119	80
Total hardness, do	6 - 2,000	218	239
Total nitrogen, do	.00- 21.0	1.61	1.75
Total phosphorus, do	.0 - 3.4	.2	.3

SPECIES INFORMATION

Refer to West (1908), Smith (1920), and Prescott (1962).

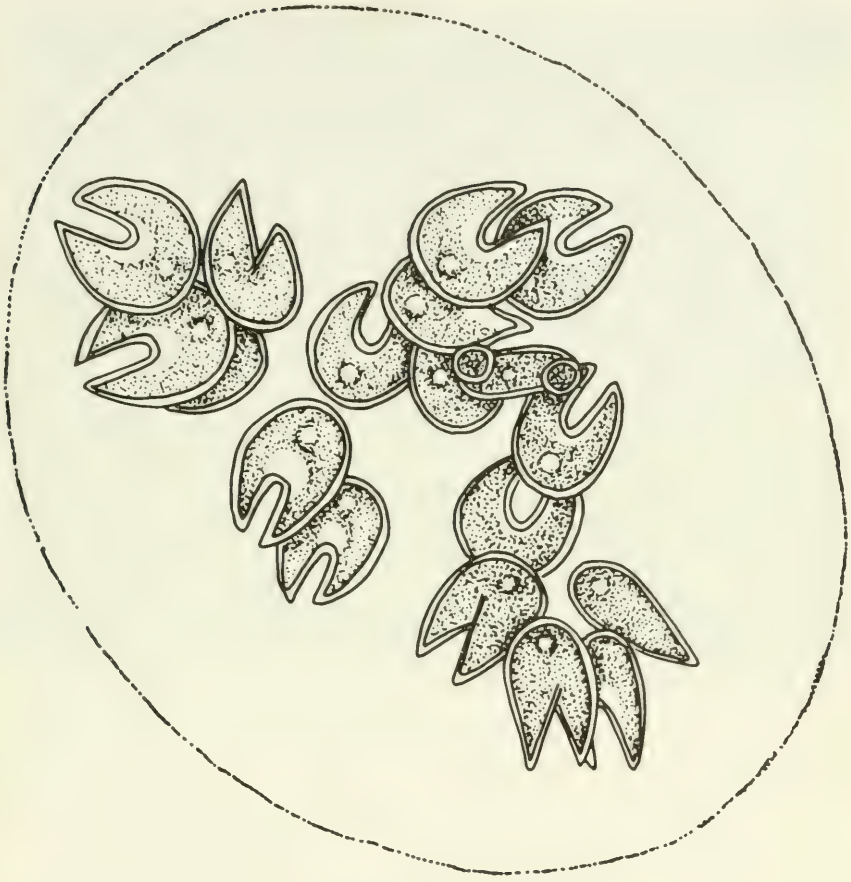

FIGURE 10. – Drawing of *Kirchneriella*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Micractiniaceae
GENUS *MICRACTINIUM* Fresenius, 1858 (fig. 11)

MORPHOLOGY

Cells are spherical to broadly ellipsoidal and 4-8 μm in diameter. The single, cup-shaped chromatophore is parietal. Each cell bears 1 to 7 long uniform setae. Cells generally are quadrately united in a 4-celled coenobium. Several coenobia are generally united.

REPRODUCTION

The cell divides asexually into 4 autospores, which are released when the parent-cell wall ruptures into 4 symmetrical parts. Oogamous sexual reproduction is by the union of a biflagellate antherozoid and an egg. The egg protrudes through an opening in the cell wall at the time of fertilization. Following fertilization, the zygote moves through the opening and becomes attached to the parent-cell wall.

OCCURRENCE

Free-floating colonies are common in the euplankton. It is generally indicative of soft-water conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature_____degrees Celsius__	0.0 – 34.0	19.0	7.9
pH_____	5.9 – 9.6	7.8	.6
Dissolved oxygen_____milligrams per liter__	.1 – 22.0	8.9	2.5
Specific conductance _____micromho__	11 –10,200	761	1,150
Total alkalinity _____milligrams per liter__	0 – 426	125	78
Total hardness _____do_____	6 – 1,500	215	206
Total nitrogen _____do_____	.03– 26.0	1.97	2.32
Total phosphorus _____do_____	.0 – 3.9	.3	.4

SPECIES INFORMATION

Refer to Tiffany (1934), Smith (1920), and Prescott (1962).

FIGURE 11. – Photomicrograph of *Micractinium*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Oocystaceae
GENUS *OOCYSTIS* Nägeli, 1855 (fig. 12)

MORPHOLOGY

Cells are ovoid, ellipsoidal, or cylindrical; 7–45 μm in diameter; and have smooth walls. A polar nodule may be present. The number of chromatophores varies from 1 to many. The genus may be solitary or in colonies of 2, 4, 8, or 16 cells surrounded by a partially gelatinous and greatly swollen parent-cell wall.

REPRODUCTION

Reproduction is asexual into 2, 4, 8, or 16 autospores. Sister autospores remain within the greatly expanded parent-cell wall and may be accompanied by several groupings of sister autospores. New colonies are formed by the rupturing of the parent-cell wall.

OCCURRENCE

Oocystis is widely distributed in the euplankton and tychoplankton. It generally is indicative of soft water or oligotrophic water. Some species (for example, *Oocystis elliptica*) are commonly found in warm shallow water intermingled among other algae.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	19.6	8.0
pH	4.4 – 9.8	7.8	.6
Dissolved oxygen, milligrams per liter	1.7 – 22.0	8.7	2.4
Specific conductance, micromho	10 –48,000	1,120	2,730
Total alkalinity, milligrams per liter	1 – 440	129	76
Total hardness, do	7 – 2,000	242	247
Total nitrogen, do	.00– 19.0	1.53	1.59
Total phosphorus, do	.0 – 3.5	.2	.3

SPECIES INFORMATION

Refer to Smith (1920), Printz (1913), and Prescott (1962).

FIGURE 12. – Photomicrograph of *Oocystis*.

Division Chlorophyta
Class Chlorophyceae
Order Volvocales
Family Volvocaceae
GENUS *PANDORINA* Bory, 1824 (fig. 13)

MORPHOLOGY

Cells are pyriform, spherical, or angular and generally 7–18 μm in diameter. Each cell had 2 flagella of equal length. The single chromatophore is cup shaped. Four, 8, 16, or 32 cells are mutually comprised in the periphery of a colony and enclosed by a copious, homogeneous envelope.

REPRODUCTION

Following a state of colonial dormancy, all cells within the colony undergo simultaneous division into daughter colonies. Each cell of the daughter colony develops 2 flagella, and a new colony is formed. Sexual reproduction is anisogamous. Free-swimming male gametes fuse terminally or laterally with somewhat larger free-swimming female gametes. The quadriflagellate zygote looses its flagella and develops a cell wall. Zygote development results in biflagellate zoospores, which secrete a gelatinous envelope and divide into a new colony.

OCCURRENCE

The alga is rarely found in abundance but frequently occurs in the euplankton of hard bodies of water. It also is found frequently among dense growths of algae in shallow waters rich in nitrogenous matter (Prescott, 1962).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.0	22.1	6.9
pH	5.2 – 9.0	7.6	.7
Dissolved oxygen, milligrams per liter	1.3 – 20.0	7.9	2.4
Specific conductance, micromho	11 – 11,800	612	993
Total alkalinity, milligrams per liter	7 – 390	117	78
Total hardness, do	6 – 1,700	181	175
Total nitrogen, do	.01 – 13.0	1.4	1.4
Total phosphorus, do	.0 – 3.1	.2	.3

SPECIES INFORMATION

Refer to Smith (1920, 1931) and Prescott (1962).

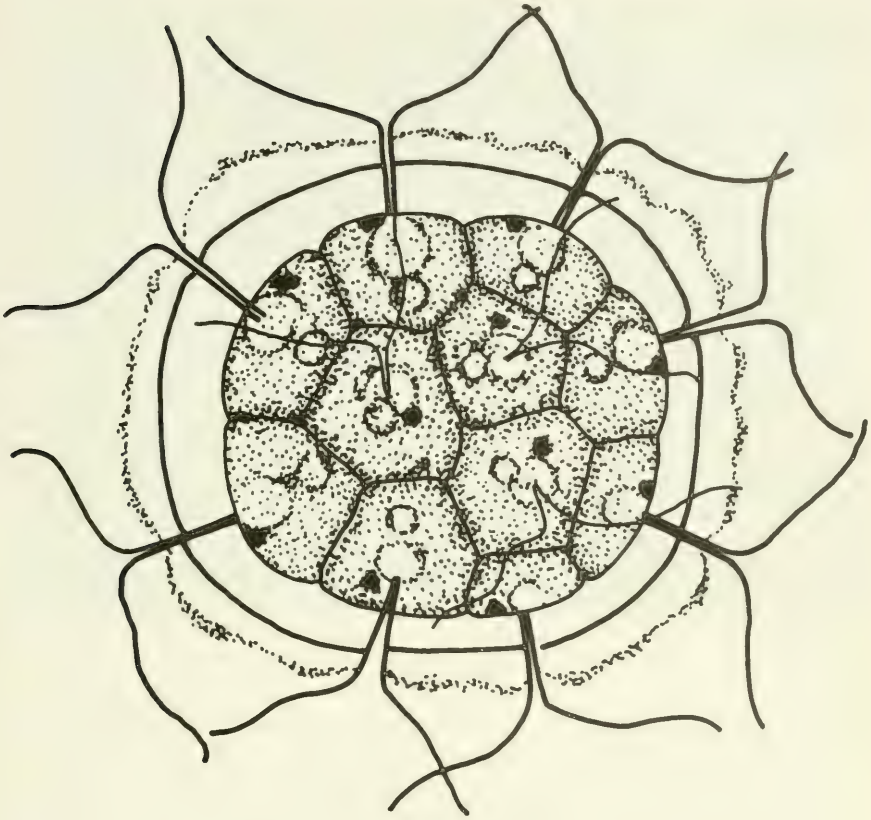

FIGURE 13.–Drawing of *Pandorina*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Hydrodictyaceae
GENUS *PEDIASTRUM* Meyen, 1829 (fig. 14)

MORPHOLOGY

Cells are coenocytic with smooth or rough walls. Peripheral cells are shaped differently from interior cells and have 1 or 2 processes. Chromatophores are discoid to diffuse. Coenobia are plate shaped and consist of 4, 8, 16, 32, 64, 128, or 256 cells and may be as much as 450 μm in diameter.

REPRODUCTION

Biflagellate zoospores formed by several cells in the colony are contained in a vesicule of the parent-cell wall. The vesicule remains until the new colony is formed and released. Isogamous sexual reproduction is by a fusion of spindle-shaped biflagellate gametes formed like the zoospores.

OCCURRENCE

The genus is widely distributed in the euplankton and tychoplankton of all types of waters. Some species are indicative of particular environmental conditions; for example, *Pediastrum simplex* is indicative of oligotrophic waters, whereas *Pediastrum duplex* or *Pediastrum Boryanum* are indicative of eutrophic waters. The genus can occur in great numbers.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	20.7	7.2
pH	4.9 – 9.8	7.7	.6
Dissolved oxygen, milligrams per liter	1.1 – 20.0	8.4	2.3
Specific conductance, micromho	30 – 14,000	616	841
Total alkalinity, milligrams per liter	4 – 440	119	74
Total hardness, do	5 – 1,400	189	157
Total nitrogen, do	.00 – 24.0	1.6	2.0
Total phosphorus, do	.0 – 3.6	.2	.4

SPECIES INFORMATION

Refer to Brunnthaler (1915), Bigeard (1933), Harper (1916, 1918), and Prescott (1962).

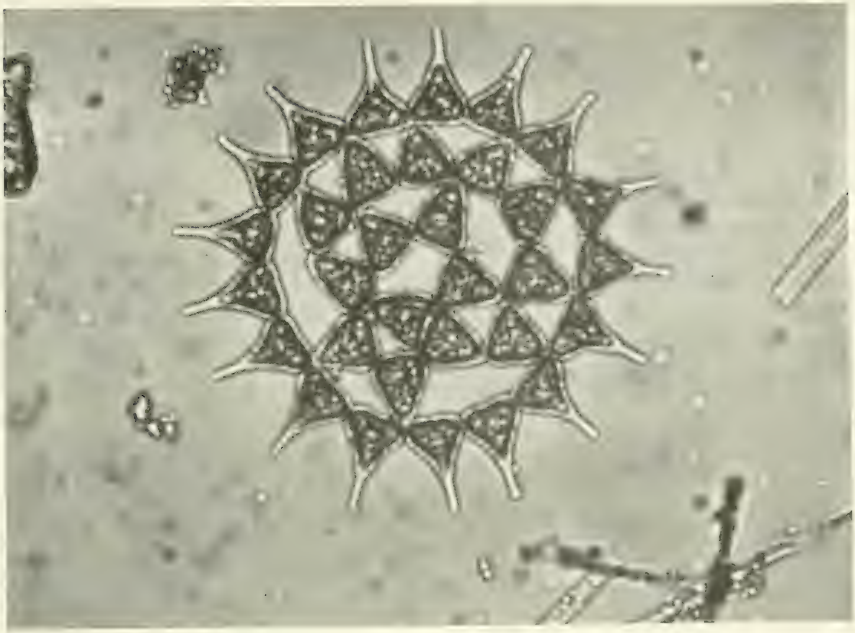

FIGURE 14.—Photomicrograph of *Pediastrum*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Scenedesmaceae
GENUS *SCENEDESMUS* Meyen, 1829 (fig. 15)

MORPHOLOGY

Cells are ellipsoidal, oblong, fusiform, acicular, or ovoid. The single chromatophore is parietal. Cell walls are smooth, corrugated, granulate, or spicate with or without marginal or lateral teeth or spines. Coenobia are flat and consist of 2, 4 (most commonly), or 8 cells but sometimes as many as 16 or 32 cells.

REPRODUCTION

Transverse and longitudinal divisions into 2, 4, 8, 16, or 32 autospores are undertaken by a parent cell. The parent-cell wall splits longitudinally, releasing the daughter colony.

OCCURRENCE

The genus is widely distributed in the euplankton, tychoplankton, and periphyton. It is found in all types of waters. The commonly occurring species, *Scenedesmus quadricauda*, is one of the most nearly ubiquitous algal species. Great numbers, so as to color the water green, may occur in small pools.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 37.0	18.1	8.4
pH	3.4 – 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	.1 – 22.0	8.7	2.5
Specific conductance, micromho	10 – 48,000	863	1,800
Total alkalinity, milligrams per liter	0 – 480	119	80
Total hardness, do	3 – 2,000	221	254
Total nitrogen, do	.00 – 26.0	1.6	2.0
Total phosphorus, do	.0 – 4.0	.2	.3

SPECIES INFORMATION

Refer to Chodat (1926), Smith (1916), and Prescott (1962).

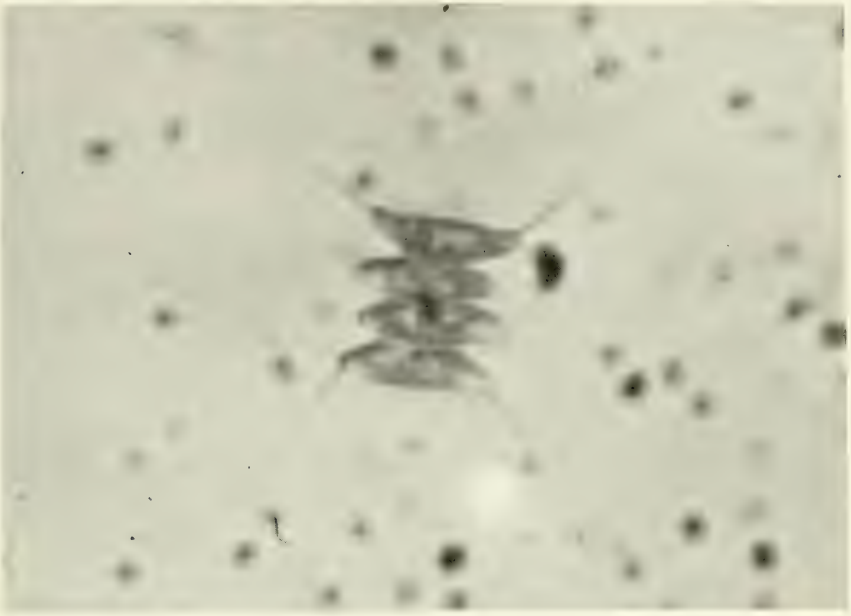

FIGURE 15. – Photomicrograph of *Scenedesmus*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Characiaceae
GENUS *SCHROEDERIA* Lemmermann, 1899 (fig. 16)

MORPHOLOGY

Solitary cells are acicular to fusiform and are straight or slightly curved. Cell apices are tapered into setae; one may be bifurcate. Total cell length, including setae, may exceed 150 μm. The single chromatophore is H-shaped. Eyespot may or may not be present.

REPRODUCTION

Biflagellate zoospores (4 or 8) form within the cell and are released by transverse splitting of the parent-cell wall. The zoospore loses its flagella and develops into a vegetative cell.

OCCURRENCE

The solitary, free-floating cells of the genus are found in the euplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	20.0	8.0
pH	5.3 – 9.6	7.7	.6
Dissolved oxygen, milligrams per liter	.1 – 20.7	8.2	2.2
Specific conductance, micromho	10 – 35,000	899	2,145
Total alkalinity, milligrams per liter	0 – 400	124	78
Total hardness, do	6 – 1,700	216	227
Total nitrogen, do	.00 – 17.0	1.55	1.81
Total phosphorus, do	.0 – 3.5	.2	.4

SPECIES INFORMATION

Refer to Smith (1920, 1926) and Prescott (1962).

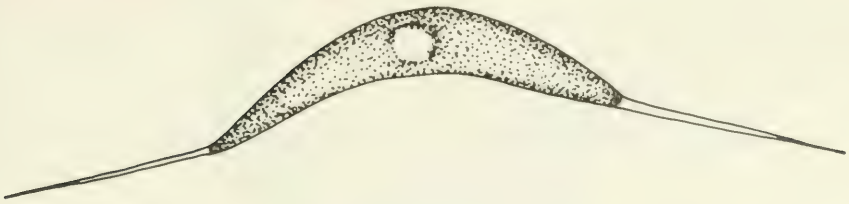

FIGURE 16. – Drawing of *Schroederia*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Oocystaceae
GENUS *SELENASTRUM* Reinsch, 1867 (fig. 17)

MORPHOLOGY

Cells are arcuate to lunate with apices acutely pointed. The single chromatophore is parietal. Convex surfaces of 4, 8, or 16 cells are apposed; a colony may have as many as 100 or more cells. There is no gelatinous envelope.

REPRODUCTION

The cell contents divide into 4, 8, or 16 autospores, which generally remain opposed to one another following release from the parent-cell wall.

OCCURRENCE

Selenastrum is widely distributed in the euplankton. It is found sparingly intermingled with other free-floating algae in pools and other quiet waters (Smith, 1950). Some species occur in soft, acidic waters.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.5	19.1	7.7
pH	4.4 – 9.4	7.7	.7
Dissolved oxygen, milligrams per liter	.4 – 18.3	8.5	2.4
Specific conductance, micromho	25 –24,800	723	1,280
Total alkalinity, milligrams per liter	0 – 500	118	81
Total hardness, do	4 – 2,000	203	206
Total nitrogen, do	.00– 17.0	1.57	1.55
Total phosphorus, do	.0 – 3.6	.2	.4

SPECIES INFORMATION

Refer to Collins (1909), Smith (1920), and Prescott (1962).

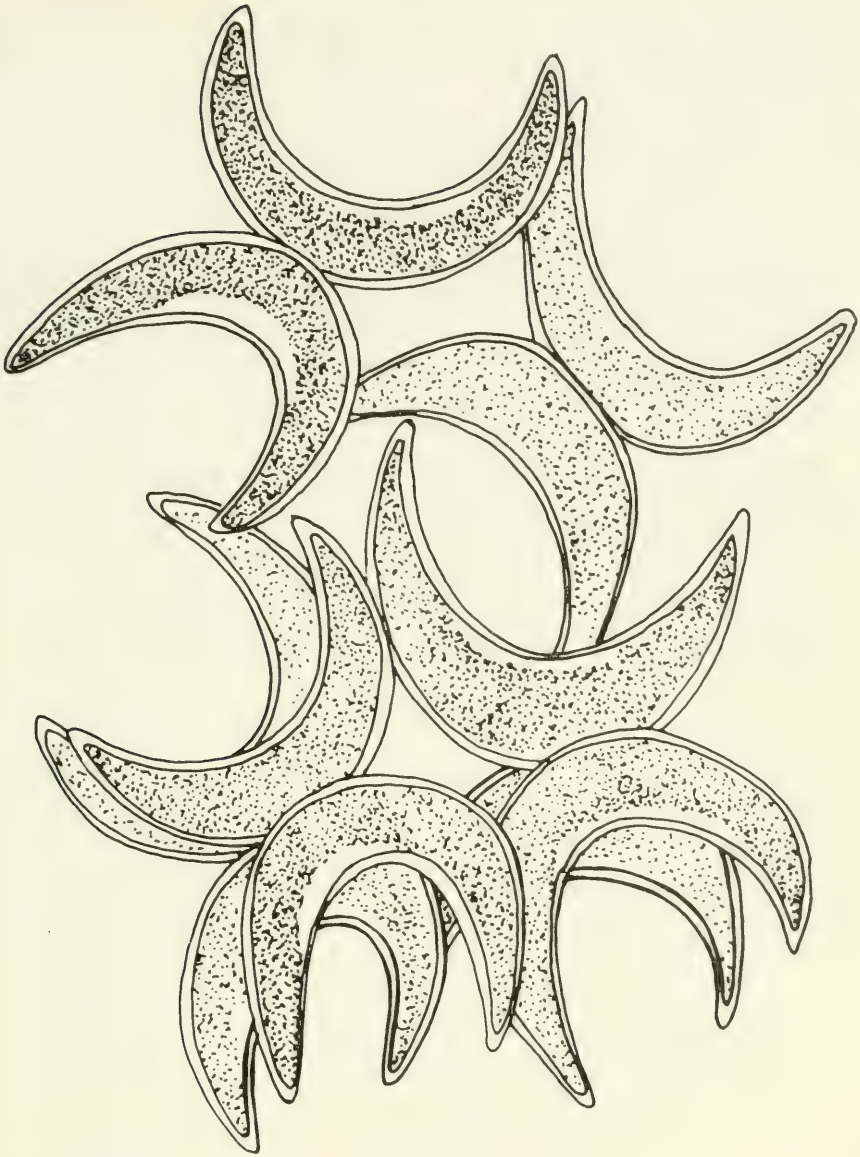

FIGURE 17. – Drawing of *Selenastrum*.

Division Chlorophyta
Class Chlorophyceae
Order Tetrasporales
Family Palmellaceae

GENUS *SPHAEROCYSTIS* Chodat, 1897 (fig. 18)

MORPHOLOGY

Cells are spherical and are as much as 25 μm in diameter. Cup-shaped chromatophores may fill entire cell. The spherical colony consists of groups of 4, 8, 16, or 32 cells arranged toward the periphery of a hyaline, homogeneous envelope.

REPRODUCTION

A colonial cell divides into 4 or 8 daughter cells, which are enveloped in a distinct gelatinous envelope. The daugher colony is released by a softening of the parent-colony matrix.

OCCURRENCE

The genus is widely distributed in the euplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.3	20.9	6.7
pH	4.9 – 9.3	7.6	.7
Dissolved oxygen, milligrams per liter	.4 – 15.9	8.2	2.1
Specific conductance, micromho	10 –9,800	689	1,290
Total alkalinity, milligrams per liter	6 – 400	107	80
Total hardness, do	5 –1,800	189	237
Total nitrogen, do	.05– 17.0	1.49	1.93
Total phosphorus, do	.0 – 2.8	.2	.2

SPECIES INFORMATION

Refer to Smith (1920) and Prescott (1962).

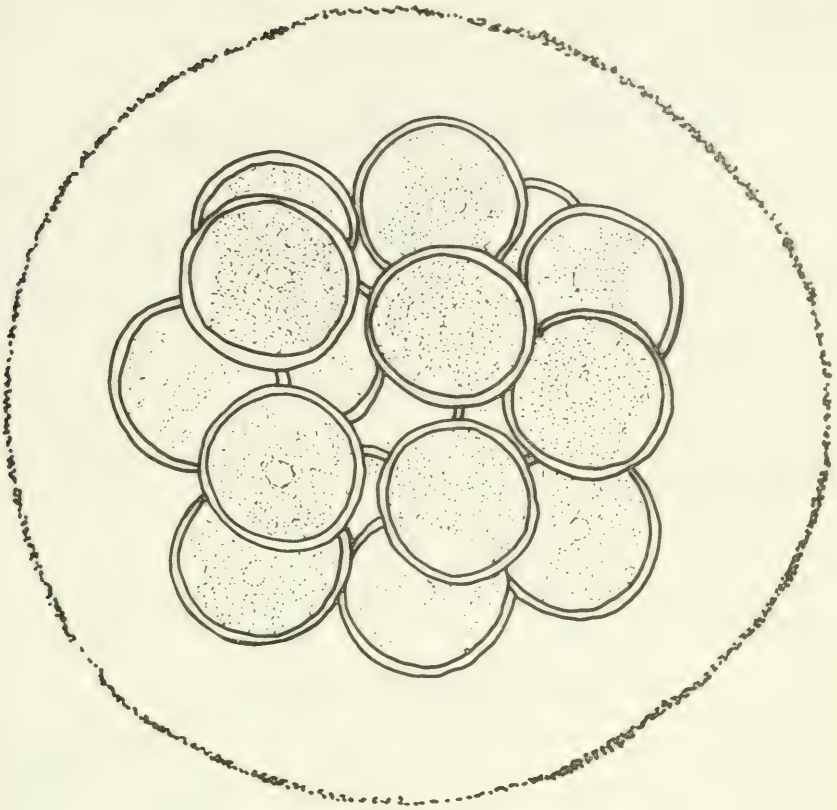

FIGURE 18. – Drawing of *Sphaerocystis*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Oocystaceae
GENUS *TETRAEDRON* Kützing, 1845 (fig. 19)

MORPHOLOGY

Solitary cells are polyhedral. Angles of the cells may be simple or produced into simple or furcate processes. Cell wall may be smooth or verrucose. Cell may contain 1 to many parietal discoid to angular chromatophores.

REPRODUCTION

The cell divides into 2, 4, 8, 16, or 32 autospores, which are immediately released by rupture of the parent-cell wall.

OCCURRENCE

The genus is widely distributed, particularly in the euplankton and tychoplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature_____degrees Celsius__	0.0 – 34.0	20.8	6.8
pH_____	4.7 – 9.6	7.7	.6
Dissolved oxygen_____milligrams per liter__	.4 – 20.7	8.3	2.3
Specific conductance_____micromho__	10 –14,800	698	1,130
Total alkalinity_____milligrams per liter__	0 – 440	114	75
Total hardness_____do_____	6 – 1,800	189	184
Total nitrogen_____do_____	.03– 21.0	1.37	1.50
Total phosphorus_____do_____	.0 – 2.9	.2	.3

SPECIES INFORMATION

Refer to Brunnthaler (1915), Reinsch (1888), Smith (1920, 1926), and Prescott (1962).

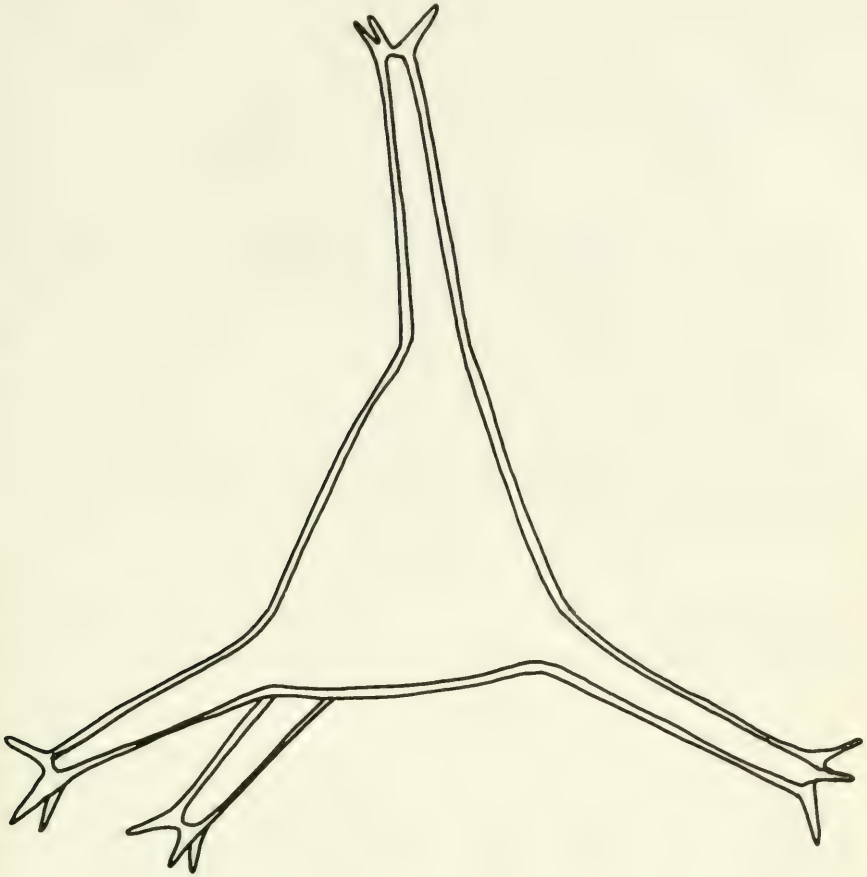

FIGURE 19. – Drawing of *Tetraedron*.

Division Chlorophyta
Class Chlorophyceae
Order Chlorococcales
Family Scenedesmaceae
GENUS *TETRASTRUM* Chodat, 1895 (fig. 20)

MORPHOLOGY

Cells, 4-10 μm in diameter, are elliptical, triangular, trapezoidal, or semicircular. Each cell has one or more spines on the free face. One to 4 cup-shaped chromatophores are parietal. Cells are joined quadrately to form a 4-celled coenobia.

REPRODUCTION

A cell divides into 4 autospores that remain quadrately attached. Cellular spines develop following release by rupture of the parent-cell wall.

OCCURRENCE

Tetrastrum has a widespread distribution, but it is found generally only in very few numbers. It is common in the euplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 - 34.0	19.1	7.8
pH	4.9 - 9.4	7.8	.6
Dissolved oxygen, milligrams per liter	1.7 - 19.7	8.8	2.3
Specific conductance, micromho	10 -9,800	741	998
Total alkalinity, milligrams per liter	2 - 477	129	76
Total hardness, do	5 -2,000	215	184
Total nitrogen, do	.01- 19.0	1.72	1.71
Total phosphorus, do	.0 - 3.7	.2	.3

SPECIES INFORMATION

Refer to Ahlstrom and Tiffany (1934) and Prescott (1962).

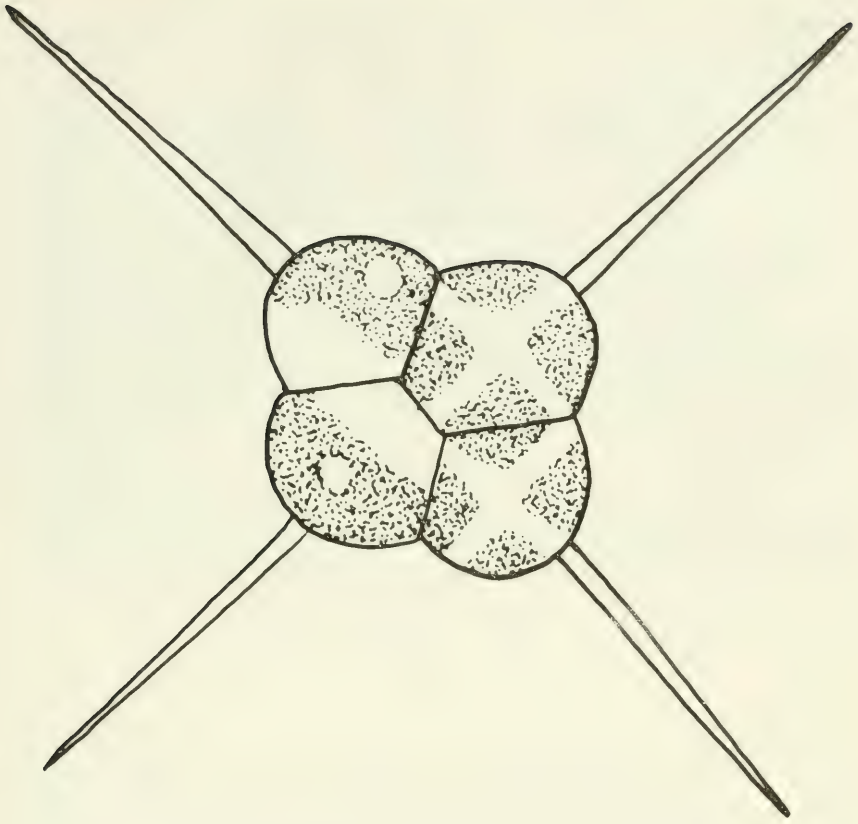

FIGURE 20. – Drawing of *Tetrastrum*.

Division Euglenophyta
Class Euglenophyceae
Order Euglenales
Family Euglenaceae
GENUS *EUGLENA* Ehrenberg, 1838 (fig. 21)

MORPHOLOGY

Cell is elongate, oblong, lanceolate, or spindle shaped; rigidly or spirally twisted; solitary; sometimes attenuate at posterior end; and as much as 450 μm in length. Each cell contains a single flagellum. A cell has a gullet at the anterior end and one or more contractile vacuoles adjoining a flask-shaped reservoir. Eyespot is generally present. Chromatophores are numerous and discoid to band shaped.

REPRODUCTION

Reproduction is by longitudinal division of the cell beginning at the anterior end. Occasionally, a cell becomes immobile and surrounded by a gelatinous sheath, following which cell division occurs. This is called a palmelloid colony.

OCCURRENCE

Euglena is of widespread distribution mostly in the tychoplankton. It is very indicative of waters rich in organic matter, for example, those below domestic sewage outfalls. It can occur in such abundance as to color the water a deep green (Smith, 1950). Occasionally, the light-induced production of haematochrome in abundant cells will color a body of water brick red (Prescott, 1962).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	18.3	8.4
pH	4.1 – 10.0	7.7	.6
Dissolved oxygen, milligrams per liter	.1 – 22.0	8.6	2.8
Specific conductance, micromho	10 –48,000	1,240	2,680
Total alkalinity, milligrams per liter	0 – 500	146	88
Total hardness, do	3 – 2,000	284	299
Total nitrogen, do	.01– 28.0	2.11	2.59
Total phosphorus, do	.0 – 4.0	.3	.5

SPECIES INFORMATION

Refer to Johnson (1944) and Prescott (1962).

FIGURE 21. – Photomicrograph of *Euglena*.

Division Euglenophyta
Class Euglenophyceae
Order Euglenales
Family Euglenaceae

GENUS *TRACHELOMONAS* Ehrenberg, 1833 (fig. 22)

MORPHOLOGY

Cell is solitary and uniflagellate and loosely encased in a globose or ellipsoidal lorica. The surface of the lorica may be smooth, punctate, spiny, reticulate, or striate. There are 2 to 15 parietal, discoid chromatophores.

REPRODUCTION

Prior to division into 2 daughter cells, the parent cell becomes immobile. One daughter cell is released to form a new lorica. The remaining daughter cell retains the parent-cell lorica.

OCCURRENCE

The genus is very indicative of warm waters having a high content of organic matter. It can occur in such abundance as to color the water brown. It is found primarily in the tychoplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	18.3	8.5
pH	4.0 – 9.8	7.6	.7
Dissolved oxygen, milligrams per liter	.2 – 20.6	8.6	2.6
Specific conductance, micromho	10 –48,000	753	1,970
Total alkalinity, milligrams per liter	0 – 500	113	83
Total hardness, do	3 – 1,800	197	222
Total nitrogen, do	.02– 38.0	1.60	1.87
Total phosphorus, do	.0 – 3.6	.2	.3

SPECIES INFORMATION

Refer to Deflandre (1926), Skvortzow (1925), and Prescott (1962).

FIGURE 22.—Photomicrograph of *Trachelomonas*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Achnanthaceae
GENUS *ACHNANTHES* Bory, 1822 (fig. 23)

MORPHOLOGY

Cells are rectangular and longitudinally bent or curved in girdle view. They generally are attached by gelatinous stalks or are sessile and united into bundles at the valves, rarely into filaments. Values are generally linear-lanceolate to elliptical. The epitheca is convex and has a pseudoraphe; the hypotheca is commonly concave and has a raphe, inconspicuous polar nodules, a distinct center nodule, and sometimes a stauros. Striae are transverse or radiate. Costae are prominant in some species. There are 1, 2, or numerous discoid chromatophores.

REPRODUCTION

Auxospore formation is by conjugation of paired gametes, 2 of which are formed from each of 2 protoplasts.

OCCURRENCE

The genus is widely distributed. Freshwater species are generally epiphytic upon filamentous chlorophytes and submerged phanerogams. They are found frequently in the tychoplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.5	13.4	8.3
pH	3.4 – 9.7	7.5	.7
Dissolved oxygen, milligrams per liter	.8 – 20.6	9.7	2.4
Specific conductance, micromho	10 – 37,400	539	1,290
Total alkalinity, milligrams per liter	0 – 480	95	76
Total hardness, do	5 – 2,000	164	226
Total nitrogen, do	.00– 32.0	1.12	1.42
Total phosphorus, do	.0 – 3.5	.1	.3

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

FIGURE 23. – Photomicrograph of *Achnanthes*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Cymbellaceae
GENUS *AMPHORA* Ehrenberg, 1840 (fig. 24)

MORPHOLOGY

Cells are commonly sessile, with concave faces attached in girdle view. They are broadly elliptical in outline and have truncated ends. Girdles generally are separated by several punctate or striate intercalary bands. Values are lunate, longitudinally asymmetrical, and transversely striate. Raphe is gibbous, with a central nodule close to the concave margin. Some species have a single chromatophore which lies next to the concave girdle face; other species have 2 or 4 chromatophores.

REPRODUCTION

Two gametes are formed from the protoplast of 2 approximate cells and unite to form 2 auxospores. Geitler (1929) observed the production of a single auxospore from a single cell.

OCCURRENCE

Amphora is widely distributed. Freshwater species commonly are found in circumneutral waters having a fairly high nutrient content.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	14.3	8.4
pH	4.9 – 9.6	7.8	.6
Dissolved oxygen, milligrams per liter	2.7 – 20.0	9.6	2.3
Specific conductance, micromho	22 – 48,600	1,860	5,500
Total alkalinity, milligrams per liter	0 – 480	137	81
Total hardness, do	4 – 2,000	269	281
Total nitrogen, do	.00 – 38.0	1.64	2.50
Total phosphorus, do	.0 – 3.6	.2	.4

SPECIES INFORMATION

Refer to Cleve (1895) and Boyer (1927a).

FIGURE 24. – Photomicrograph of *Amphora*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Fragilariaceae
GENUS *ASTERIONELLA* Hassall, 1850 (fig. 25)

MORPHOLOGY

Cells are joined to one another at their ends to form flat stellate colonies. Cell length may reach 130 μm; cell diameter is about 1–2 μm. Valves are linear with inflated ends and are symmetrical in valve and girdle views. They are finely transversely striated. Intercalary bands, septa, and costae are lacking. The pseudoraphe is indistinct. There are 2 (generally) to several lobed chromatophores.

REPRODUCTION

Reproduction is probably by the formation of an auxospore within a single cell.

OCCURRENCE

Asterionella is a commonly occurring alga in the euplankton. It is indicative of mesotrophic to eutrophic conditions. They may occur in such abundance as to impart a fishy taste to the water (Whipple and others, 1948).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 31.0	10.6	7.5
pH	4.7 – 9.4	7.6	.6
Dissolved oxygen, milligrams per liter	2.0 – 16.6	10.3	2.2
Specific conductance, micromho	19 –8,000	342	389
Total alkalinity, milligrams per liter	0 – 371	92	63
Total hardness, do	2 –1,400	127	104
Total nitrogen, do	.01– 14.0	1.13	1.14
Total phosphorus, do	.0 – 2.3	.1	.1

SPECIES INFORMATION

Refer to Meister (1912), Boyer (1927a), and Patrick and Reimer (1966).

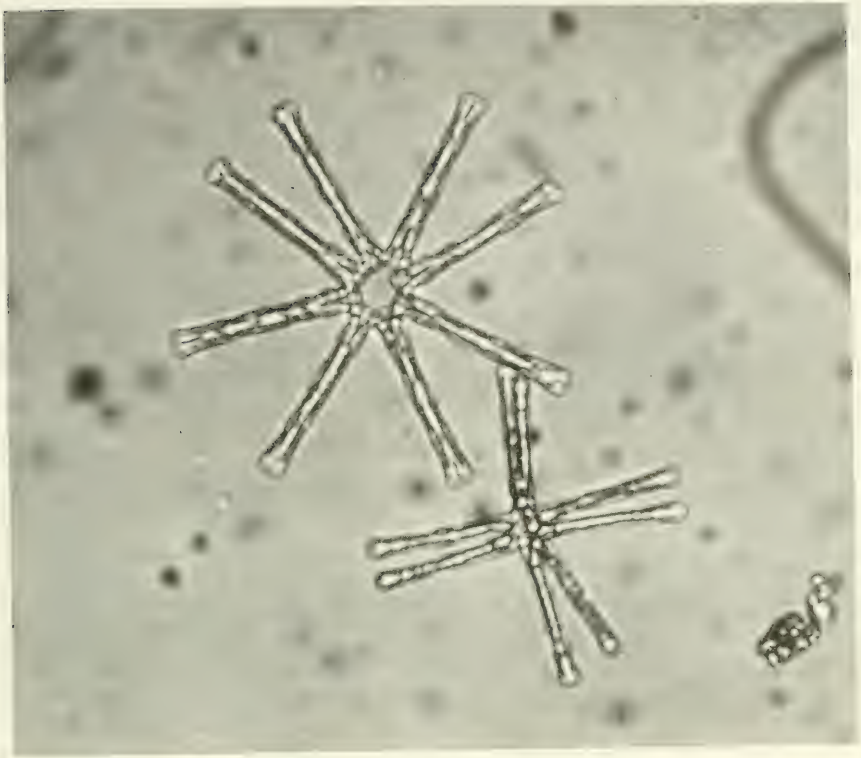

FIGURE 25.—Photomicrograph of *Asterionella*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Achnanthaceae

GENUS *COCCONEIS* Ehrenberg, 1838 (fig. 26)

MORPHOLOGY

Solitary cells are transversely curved in girdle view and broadly elliptical in valve view. Epitheca has an axial pseudoraphe and transverse striae or punctae. Hypotheca has a median raphe that is straight or sigmoid and has a central or polar nodule. Striae and punctae generally are transverse. A single, laminate chromatophore adjoins the epitheca.

REPRODUCTION

A single auxospore is formed by the conjugation of 2 approximate cells.

OCCURRENCE

Species of the genus are almost exclusively epiphytic upon filamentous chlorophytes. It is widely distributed. Occurrence of the genus in the plankton generally results from sloughing of the periphyton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	14.4	8.5
pH	4.1 – 10.0	7.7	.6
Dissolved oxygen, milligrams per liter	.8 – 20.0	9.4	2.3
Specific conductance, micromho	10 – 48,000	578	1,450
Total alkalinity, milligrams per liter	0 – 480	114	75
Total hardness, do	4 – 2,000	169	165
Total nitrogen, do	.00– 38.0	1.19	1.63
Total phosphorus, do	.0 – 3.9	.2	.3

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

FIGURE 26. – Scanning electronmicrograph of *Cocconeis*.

Division Chrysophyta
Class Bacillariophyceae
Order Centrales
Family Coscinodiscaceae

GENUS *CYCLOTELLA* Kützing, 1834 (fig. 27)

MORPHOLOGY

Discoid, drum-shaped cells are solitary (generally), filamentous, or in a colonial gelatinous envelope. The valve view is circular or rarely elliptical. Ornamentation is in 2 concentric regions: the outer region is radially striate or punctate, and the inner region is smooth or very finely punctate. Intercalary bands are lacking. There are numerous small, discoid chromatophores.

REPRODUCTION

A single auxospore is formed within a cell.

OCCURRENCE

The genus is widely distributed in all types of surface waters.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 37.0	16.1	8.7
pH	3.4 – 10.0	7.7	.6
Dissolved oxygen, milligrams per liter	.1 – 22.0	9.1	2.5
Specific conductance, micromho	10 – 49,800	918	2,570
Total alkalinity, milligrams per liter	0 – 500	119	78
Total hardness, do	3 – 2,000	217	250
Total nitrogen, do	.00– 41.0	1.58	1.96
Total phosphorus, do	.0 – 4.0	.2	.4

SPECIES INFORMATION

Refer to Boyer (1927a).

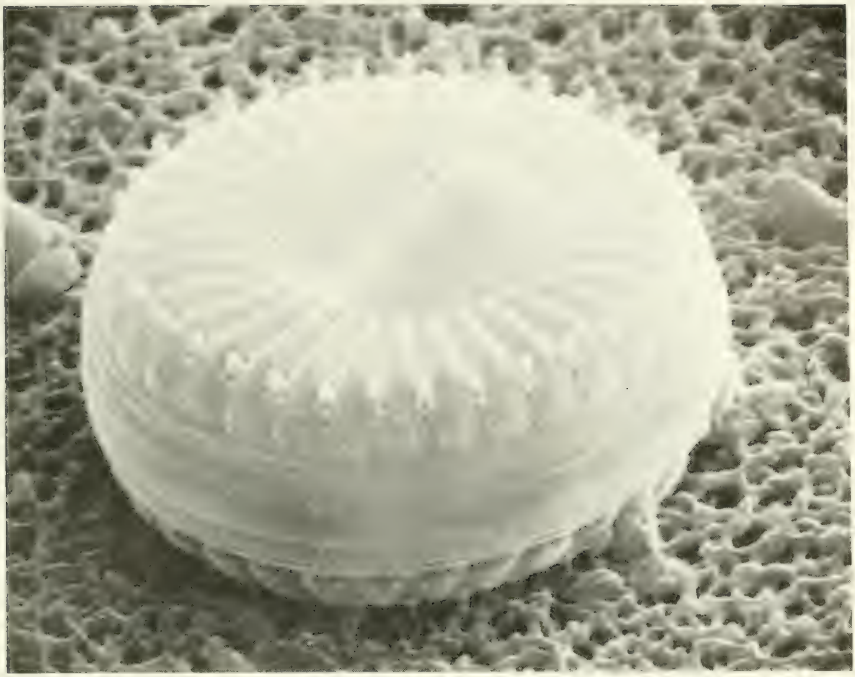

FIGURE 27. – Scanning electronmicrograph of *Cyclotella*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Cymbellaceae
GENUS *CYMBELLA* Agardh, 1830 (fig. 28)

MORPHOLOGY

Solitary cells are free floating, attached at the ends of gelatinous stalks, or contained within branched gelatinous tubes. Cell is longitudinally asymmetrical in valve view and is lunate, subellipitical, rhombic, or naviculoid. It is ventrally concave and dorsally convex. The raphe is curved and contains well-defined nodules. Ornamentations consist of radiating transverse striae or punctae. Intercalary bands are lacking. A single chromatophore is plate shaped.

REPRODUCTION

Two gamates are formed from the protoplast of 2 approximate cells and unite to form 2 auxospores.

OCCURRENCE

A distinctly freshwater genus, *Cymbella* is widely distributed in the euplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature_____degrees Celsius__	0.0 – 34.0	13.5	8.2
pH_____	3.4 – 10.0	7.6	.7
Dissolved oxygen_____milligrams per liter__	1.1 – 20.6	9.7	2.2
Specific conductance_____micromho__	10 –49,800	647	2,250
Total alkalinity_____milligrams per liter__	0 – 430	100	74
Total hardness_____do_____	3 – 2,000	164	194
Total nitrogen_____do_____	.00– 28.0	1.17	1.53
Total phosphorus_____do_____	.0 – 3.9	.1	.3

SPECIES INFORMATION

Refer to Boyer (1927a).

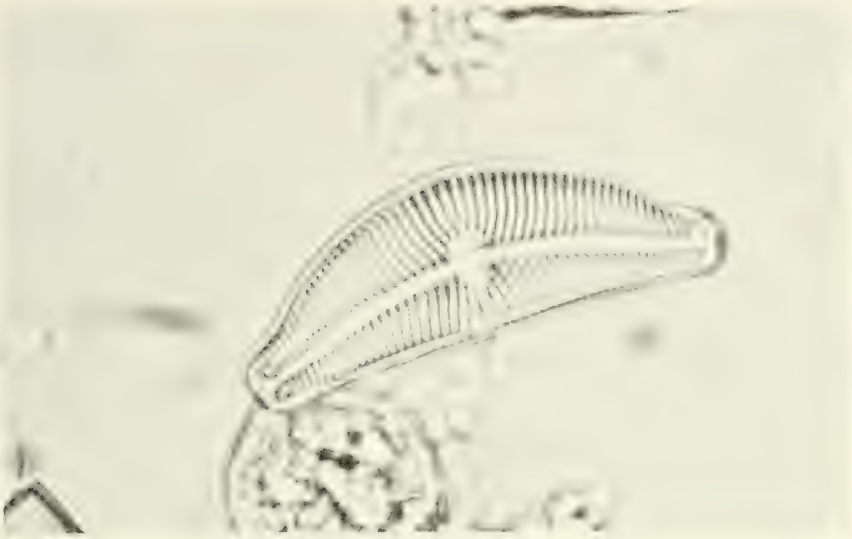

FIGURE 28. – Photomicrograph of *Cymbella*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Diatomaceae

GENUS *DIATOMA* DeCandolle, 1805 (fig. 29)

MORPHOLOGY

Cells are rectangularly tabular in girdle view and united at the corner into free-floating or sessile zigzag to linear chains. There are 1 to 2 intercalary bands. Several transverse septa appear as transverse costae. Cells are lanceolate to linear and bilaterally symmetrical. Valves contain transverse, finely punctate striations between the costae. The narrow pseudoraphe does not have a median expansion. Numerous chromatophores are elliptical.

REPRODUCTION

A single auxospore is formed within a cell.

OCCURRENCE

The genus is widely distributed in cool water. Some species are indicative of particular environmental conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	11.3	8.1
pH	4.4 – 10.0	7.8	.6
Dissolved oxygen, milligrams per liter	1.2 – 20.6	10.1	2.3
Specific conductance, micromho	12 – 43,400	599	1,400
Total alkalinity, milligrams per liter	0 – 420	120	71
Total hardness, do	3 – 1,600	182	160
Total nitrogen, do	.00 – 41.0	1.38	1.98
Total phosphorus, do	.0 – 3.9	.2	.3

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

FIGURE 29.—Photomicrograph of *Diatoma*.

Division Chrysophyta
Class Chrysophyceae
Order Chrysomonadales
Family Ochromonadaceae
GENUS *DINOBRYON* Ehrenberg, 1835 (fig. 30)

MORPHOLOGY

Cells are free floating, sessile, or ephiphytic and may be solitary or in colonies. They are enclosed in conical, campanulate, or cylindrical cellulose lorica, which have smooth or undulate walls, pointed bases, and open tops. Colonies may be arbuscular, divergent, or compact. The conical or ovoid protoplast is attached to the base or side of the lorica and contains 2 flagella of unequal length. Each cell has 1 to 2 elongate, parietal, golden-brown chromatophores, several contractile vacuoles, and 1 apical eyespot.

REPRODUCTION

Longitudinal division of a cell results in 2 daughter cells, which become attached to the mouth of the parent-cell lorica. New lorica are formed. Pascher (1943) observed both palmelloid stages and statospores.

OCCURRENCE

Dinobryon is widely distributed and generally is indicative of hard waters. It commonly is intermingled with other algae in pools and ditches (Smith, 1950).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.5	13.6	8.3
pH	4.1 – 9.0	7.4	.7
Dissolved oxygen, milligrams per liter	.7 – 14.7	9.7	2.4
Specific conductance, micromho	11 –7,700	313	447
Total alkalinity, milligrams per liter	0 – 477	83	72
Total hardness, do	5 –1,700	122	134
Total nitrogen, do	.00– 12.0	.91	.99
Total phosphorus, do	.0 – 2:1	.1	.1

SPECIES INFORMATION

Refer to Ahlstrom (1937).

FIGURE 30.—Photomicrograph of *Dinobryon*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Cymbellaceae
GENUS *EPITHEMIA* de Brébisson, 1838 (fig. 31)

MORPHOLOGY

The solitary cells are commonly epiphytic upon submerged macrophytes. They are attached at the girdle, are rectangular in girdle view, and have smooth girdles and intercalary bands. Valves are slightly to strongly curved dorsally convex, and ventrally straight to concave. Poles are broadly rounded to capitate and sometimes recurved. The axial field is next to the concave side, but its central portion bends sharply inward to form a V-shaped structure midway between the poles. A raphe contains polar and central nodules. Transverse septa appear as costae and alternate with 2 or more rows of punctae. There is generally a single chromatophore next to the concave girdle side, which has irregular projections extending along both valve faces.

REPRODUCTION

Protoplasts of approximate frustules each form 2 gametes, which unite to form 2 auxospores.

OCCURRENCE

The genus is widely distributed, particularly in the tychoplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 32.0	11.9	7.6
pH	3.7 – 9.2	7.8	.6
Dissolved oxygen, milligrams per liter	3.9 – 15.1	10.0	2.1
Specific conductance, micromho	30 –40,100	630	2,360
Total alkalinity, milligrams per liter	0 – 350	111	65
Total hardness, do	5 – 1,700	149	147
Total nitrogen, do	.00– 36.0	1.11	2.17
Total phosphorus, do	.0 – 3.5	.2	.3

SPECIES INFORMATION

Refer to Meister (1912), Boyer (1927a), and Patrick and Reimer (1966).

FIGURE 31. – Scanning electronmicrograph of *Epithemia*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Eunotiaceae
GENUS *EUNOTIA* Ehrenberg, 1837 (fig. 32)

MORPHOLOGY

Cells are solitary or joined valve to valve into chains. They are free floating or epiphytic. Cells are rectangular, linear, or tabular in girdle view. Both girdles and valves are strongly ornamented, generally with intercalary bands. Valves are arcuate having similar poles and dissimilar margins. The concave side is regular; the convex side is inflated slightly near the poles and is regular or undulate. A short raphe extends from evident polar nodules diagonally to the concave side. There are no central nodule, costae, nor septae. Two chromatophores are laminate.

REPRODUCTION

A single auxospore is formed by the conjugation of protoplasts from 2 approximate cells.

OCCURRENCE

The genus is found commonly in bodies of soft water and in slowly moving waters. They are frequently found in oligotrophic or dystrophic waters (Patrick and Reimer, 1966).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 31.0	14.2	8.2
pH	3.4 – 8.7	6.8	.9
Dissolved oxygen, milligrams per liter	.8 – 15.2	9.1	2.4
Specific conductance, micromho	23 – 45,500	283	1,816
Total alkalinity, milligrams per liter	0 – 330	44	58
Total hardness, do	3 – 680	65	101
Total nitrogen, do	.06– 8.5	.92	.79
Total phosphorus, do	.0 – 2.1	.1	.2

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

FIGURE 32. – Drawing of *Eunotia*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Fragilariaceae
GENUS *FRAGILARIA* Lyngbye, 1819; emend., Rabenhorst, 1864 (fig. 33)

MORPHOLOGY

Cells are linear to fusiform, bilaterally symmetrical, commonly attenuated at the poles, sometimes capitate, and often medially inflated. Cells are rectangular in girdle view and have 0, 1, or 2 intercalary bands. They are united into free-floating or sessile colonies, which are generally zigzag chains but sometimes are flat, stellate colonies. The pseudoraphe is narrow and indistinct or broad and prominent. Transverse striae or punctae are present. Chromatophores are numerous small discoid bodies or 1 to 4 laminate plates.

REPRODUCTION

A single auxospore is formed within a cell.

OCCURRENCE

Fragilaria is widely distributed. It generally is indicative of alkaline waters of moderate conductivity. The genus is found in the littoral zone, as well as in the euplankton (Patrick and Reimer, 1966).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 - 33.5	13.5	8.4
pH	3.4 - 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	2.0 - 18.7	9.6	2.4
Specific conductance, micromho	22 -41,000	491	1,130
Total alkalinity, milligrams per liter	0 - 480	99	69
Total hardness, do	5 - 1,800	149	163
Total nitrogen, do	.00- 28.0	1.17	1.48
Total phosphorus, do	.0 - 4.0	.2	.3

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

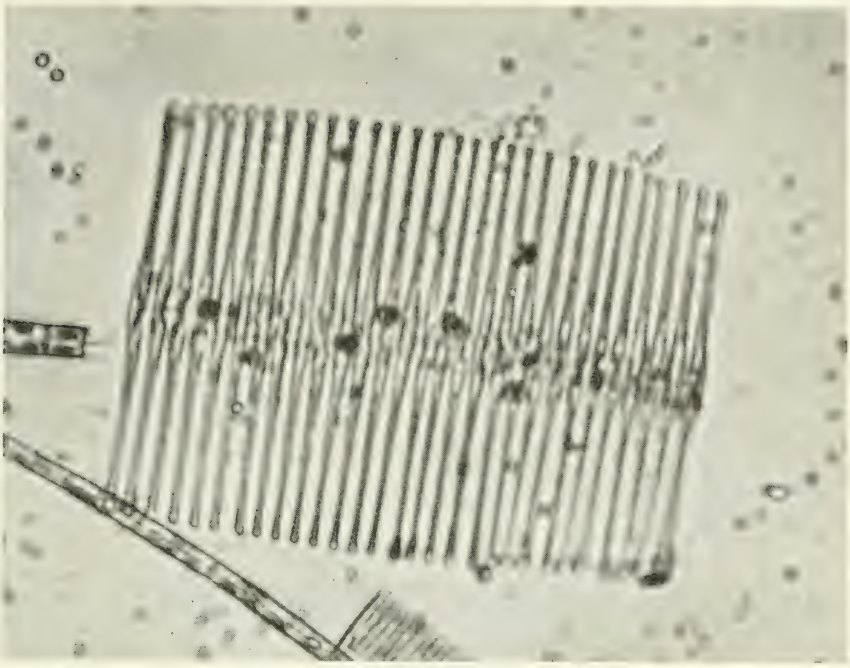

FIGURE 33. – Photomicrograph of *Fragilaria*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Gomphonemataceae
GENUS *GOMPHONEMA* Agardh, 1824 (fig. 34)

MORPHOLOGY

Cells are commonlyy epiphytic on the ends of dichotomously branched gelatinous stalks. They are sometimes sessile or solitary and free floating. Cells are transversely asymmetrical in both valve and girdle views. Cells are straight, lanceolate, or clavate. One pole is capitate or broader than the other. Intercalary bands are lacking. The raphe is straight and central and polar nodules are conspicuous. Striations are strictly transverse or somewhat radial. The chromatophore is a single, lobed plate.

REPRODUCTION

The protoplasts of 2 cells each form 2 gametes, which unite to form 2 auxospores.

OCCURRENCE

The alga is widely distributed. Freshwater species are generally epiphytic, but they occur commonly in the euplankton and tychoplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	13.0	8.3
pH	4.3 – 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	.8 – 20.6	9.8	2.4
Specific conductance, micromho	12 –37,400	574	1,260
Total alkalinity, milligrams per liter	0 – 491	105	80
Total hardness, do	4 – 1,800	171	203
Total nitrogen, do	.00– 32.0	1.43	1.93
Total phosphorus, do	.0 – 3.9	.2	.4

SPECIES INFORMATION

Refer to Boyer (1927a).

FIGURE 34.—Photomicrograph of *Gomphonema*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Naviculaceae

GENUS *GYROSIGMA* Hassall, 1845; emend., Cleve, 1894 (fig. 35)

MORPHOLOGY

Cells generally are solitary and free floating, sometimes in gelatinous tubes. They are elliptical to lanceolate in girdle view. Cells are sigmoid in outline and generally attenuated toward the acute or broadly rounded poles. Intercalary bands and septa are lacking. The sigmoid raphe has small central and polar nodules. Transverse striations cross longitudinal striations at right angles. There are two chromatophores, which are smooth or irregularly shaped plates.

REPRODUCTION

The protoplasts of 2 approximate cells each form 2 gametes. Conjugation results in the formation of 2 auxospores.

OCCURRENCE

The genus is widely distributed. It generally is indicative of alkaline waters. Some species can tolerate brackish conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	16.3	8.7
pH	4.3 – 9.0	7.6	.6
Dissolved oxygen, milligrams per liter	1.1 – 19.3	9.0	2.3
Specific conductance, micromho	32 – 47,800	1,310	3,610
Total alkalinity, milligrams per liter	0 – 386	129	80
Total hardness, do	8 – 2,000	262	305
Total nitrogen, do	.06 – 27.0	1.84	2.15
Total phosphorus, do	.0 – 4.0	.3	.4

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

FIGURE 35. – Photomicrograph of *Gyrosigma*.

Division Chrysophyta
Class Bacillariophyceae
Order Centrales
Family Coscinodiscaceae
GENUS *MELOSIRA* Agardh, 1824 (fig. 36)

MORPHOLOGY

Cells are cylindrical and united into long filaments. Cell length is greater than width. Valve view is circular. Valves may be flat or convex. If convex, they generally have a marginal ring of denticulations that unite cells into filaments. Girdles may or may not have a sulcus. If a sulcus is present, part of the girdle below the sulcus is smooth; if a sulcus is absent, the entire girdle is ornamented. Crowded chromatophores are numerous, small, and disc shaped.

REPRODUCTION

A single auxospore is formed within a cell. Microspores were observed by Schmidt (1923) in *Melosira varians*.

OCCURRENCE

Melosira, a filamentous centric alga, is one of the most ubiquitous of the algal genera. It is widely distributed in all types of waters; however, some species are indicative of particular environmental conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	16.4	8.4
pH	3.4 – 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	.1 – 20.7	9.0	2.4
Specific conductance, micromho	10 – 49,000	524	1,296
Total alkalinity, milligrams per liter	0 – 378	100	72
Total hardness, do	4 – 2,000	155	165
Total nitrogen, do	.00 – 41.0	1.43	1.70
Total phosphorus, do	.0 – 3.5	.2	.3

SPECIES INFORMATION

Refer to Boyer (1927a).

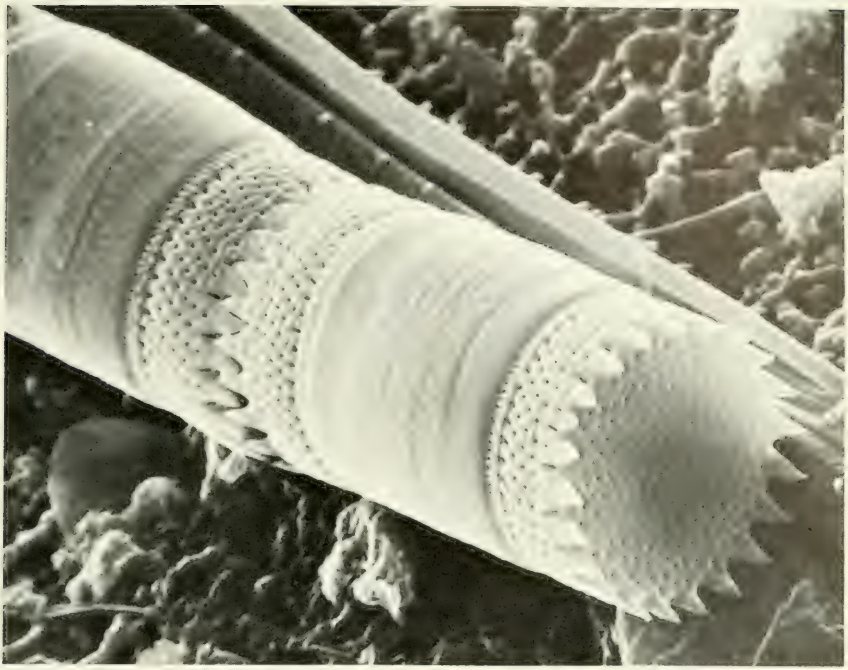

FIGURE 36. – Scanning electronmicrograph of *Melosira*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Naviculaceae
GENUS *NAVICULA* Bory, 1822 (fig. 37)

MORPHOLOGY

Cells generally are solitary and free floating but may be aggregated into irregularly radiating clusters. Cells are symmetrical, elongate, and generally attenuated toward the poles. Apices are capitate, rounded, or rostrate. Intercalary bands are lacking. The raphe is straight and central, and polar nodules are expanded. Striations are transverse, sometimes medially radiate. There are 2 (most commonly) or 4 to 8 laminate chromatophores.

REPRODUCTION

Two approximate cells each form 2 gametes. Union of gametes results in 2 auxospores.

OCCURRENCE

The genus has a widespread distribution and is found in all types of surface waters. Some species are indicative of particular environmental conditions (Patrick, 1948, 1973). According to information included in this report, *Navicula* is the second most commonly occurring genus in the phytoplankton of the United States.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 37.0	15.2	8.6
pH	3.4 – 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	.1 – 20.6	9.2	2.4
Specific conductance, micromho	10 – 49,800	940	2,960
Total alkalinity, milligrams per liter	0 – 500	111	81
Total hardness, do	3 – 2,000	205	256
Total nitrogen, do	.00 – 41.0	1.52	2.02
Total phosphorus, do	.0 – 4.0	.2	.4

SPECIES INFORMATION

Refer to Boyer (1927a), Cleve (1895), and Patrick and Reimer (1966).

FIGURE 37. – Photomicrograph of *Navicula*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Nitzschiaceae
GENUS *NITZSCHIA* Hassall, 1845 (fig. 38)

MORPHOLOGY

Cells are solitary and free floating or densely clustered in unbranched gelatinous tubes. They are generally elongate and extremely varied in outline, having somewhat attenuated poles. Valves are longitudinally asymmetrical. Keeled margin of one valve faces unkeeled margin of other valve. The raphe lies within the keel and has small central and polar nodules. A rapheal fissure has a uniseriate row of conspicuous circular pores (carinal dots) opening toward the interior of the cell. Striae or punctae are transverse. Two chromatophores on same girdle face are axial.

REPRODUCTION

Protoplasts of 2 approximate cells each form 2 gametes. Union of gametes forms 2 auxospores.

OCCURRENCE

The genus has a widespread distribution and is found in all types of waters. Some species are indicative of particular environmental conditions (Patrick, 1948, 1973). According to information included in this report, *Nitzschia* is the most commonly occurring genus in the phytoplankton of the United States.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 37.0	15.6	8.8
pH	3.4 – 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	.2 – 22.0	9.1	2.5
Specific conductance, micromho	10 – 49,800	966	2,930
Total alkalinity, milligrams per liter	0 – 500	115	81
Total hardness, do	3 – 2,000	214	259
Total nitrogen, do	.00– 36.0	1.54	2.01
Total phosphorus, do	.0 – 4.0	.2	.4

SPECIES INFORMATION

Refer to Boyer (1927a).

FIGURE 38. – Photomicrograph of *Nitzschia*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Naviculaceae
GENUS *PINNULARIA* Ehrenberg, 1840 (fig. 39)

MORPHOLOGY

Solitary, free-floating cells are symmetrical, generally straight, and have broadly rounded poles. Girdle view is rectangular; axial view is generally broad and expanded polarly and medially. Girdles are smooth. Intercalary bands are lacking. The raphe is complicated and straight or sigmoid. Costae are tubular openings in the valve wall. Two longitudinal lines are visible in the costae part of the valve. There are 2 laminate chromatophores.

REPRODUCTION

Two auxospores are formed by the union of 2 gametes from each of 2 approximate cells.

OCCURRENCE

The genus is widely distributed. It generally is indicative of calm or slowly moving, slightly acid waters having low mineral content. Sometimes *Pinnularia* is present in abundance in semipermanent or permanent pools of soft-water localities (Smith, 1950).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.5	15.8	8.2
pH	3.4 – 8.9	7.3	.9
Dissolved oxygen, milligrams per liter	1.3 – 15.2	8.9	2.1
Specific conductance, micromho	20 – 43,400	662	2,060
Total alkalinity, milligrams per liter	0 – 430	91	83
Total hardness, do	3 – 1,700	153	213
Total nitrogen, do	.09 – 32.0	1.48	2.24
Total phosphorus, do	.0 – 3.9	.2	.4

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

FIGURE 39. – Photomicrograph of *Pinnularia*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Achnanthaceae
GENUS *RHOICOSPHENIA* Grunow, 1860 (fig. 40)

MORPHOLOGY

Wedge-shaped cells are sessile and attached at the narrower end to a more or less branching system of gelatinous stalks affixed to macrophytes. Cells are 4–8 μm in diameter and 12–75 μm long. The hypotheca is concave and contains a median raphe and nodules. The epitheca is convex and contains a median pseudoraphe. In girdle view, cells are cuneate and curved in the longitudinal axis. Intercalary bands are unornamented between striated girdles. Other striations are transverse. There are 2 longitudinal septa. A single chromatophore is laminate.

REPRODUCTION

Conjugating sister cells form a single auxospore.

OCCURRENCE

The alga has a widespread distribution. The single species, *Rhoicosphenia curvata*, is found commonly in flowing alkaline waters. It is generally intolerant of saline conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 32.5	12.6	7.8
pH	5.2 – 9.3	7.8	.6
Dissolved oxygen, milligrams per liter	3.4 – 16.6	10.0	2.2
Specific conductance, micromho	10 –10,000	492	671
Total alkalinity, milligrams per liter	1 – 480	109	74
Total hardness, do	4 – 1,600	160	152
Total nitrogen, do	.00– 32.0	1.43	1.91
Total phosphorus, do	.0 – 3.1	.2	.3

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

FIGURE 40. – Photomicrograph of *Rhoicosphenia*.

Division Chrysophyta
Class Bacillariophyceae
Order Centrales
Family Coscinodiscaceae

GENUS *STEPHANODISCUS* Ehrenberg, 1845 (fig. 41)

MORPHOLOGY

Solitary, free-floating cells are discoid. Valves are circular, radially punctate, and have short marginal spines. Outer areas of punctae are in multiseriate rows; each row becomes uniseriate toward the center. Small central area is irregularly punctate. Girdles are slightly undulate and smooth and lack intercalary bands. There are 1 or 2 irregular or numerous discoid chromatophores.

REPRODUCTION

A single auxospore is formed within a cell.

OCCURRENCE

This is a widely distributed diatom. It is an insignificant component of algal communities indicating eutrophic conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.0	16.1	8.6
pH	4.6 – 9.4	7.8	.6
Dissolved oxygen, milligrams per liter	.1 – 16.6	9.3	2.4
Specific conductance, micromho	10 –10,800	533	879
Total alkalinity, milligrams per liter	3 – 470	113	64
Total hardness, do	9 – 1,800	171	165
Total nitrogen, do	.00– 24.0	1.49	1.89
Total phosphorus, do	.0 – 3.1	.2	.3

SPECIES INFORMATION

Refer to Boyer (1927a) and Skvortzow (1937).

FIGURE 41. – Scanning electronmicrograph of *Stephanodiscus*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Surirellaceae
GENUS *SURIRELLA* Turpin, 1828 (fig. 42)

MORPHOLOGY

Cells generally are solitary and free floating, are linear elliptical or ovate in valve view, have broadly rounded to subacute poles, and are rectangular naviculoid, cuneate, or sigmoid in girdle view. Girdles are smooth. Entire valve face may be in 1 plane, or it may be slightly spirally twisted. Each valve margin is keeled and contains a raphe having central and polar nodules. Parallel costae are transverse. Fine striae extend across valve face and are interrupted by a median longitudinal pseudoraphe. One chromatophore is present.

REPRODUCTION

Protoplasts from 2 cells lying end to end unite to form an auxospore.

OCCURRENCE

The alga has a widespread distribution.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 37.0	12.8	8.5
pH	3.7 – 10.0	7.7	.6
Dissolved oxygen, milligrams per liter	2.5 – 18.4	9.7	2.3
Specific conductance, micromho	29 – 35,000	985	1,910
Total alkalinity, milligrams per liter	0 – 440	137	83
Total hardness, do	6 – 1,800	260	275
Total nitrogen, do	.01 – 41.0	2.10	2.60
Total phosphorus, do	.0 – 4.0	.3	.4

SPECIES INFORMATION

Refer to Boyer (1927a).

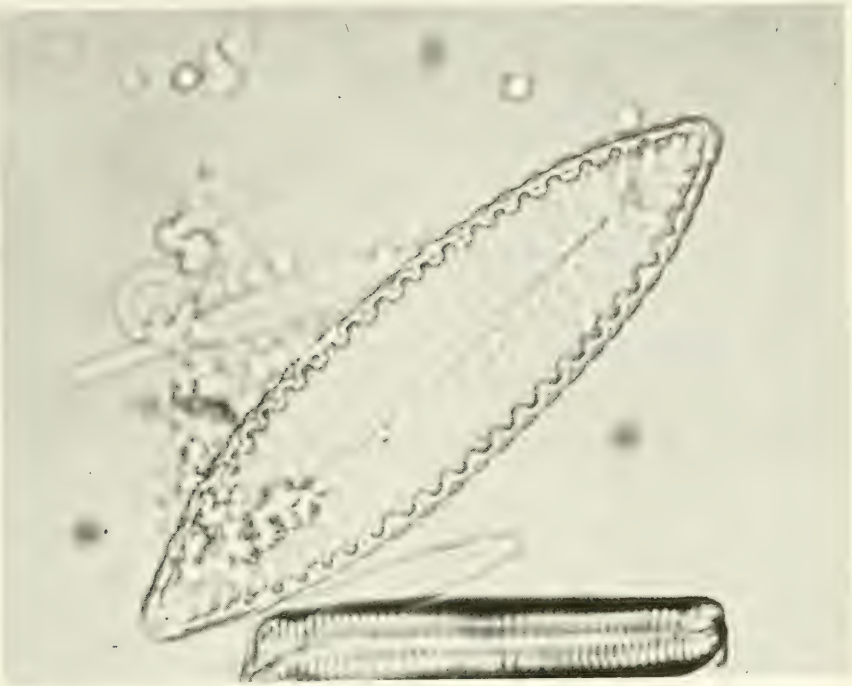

FIGURE 42. – Photomicrograph of *Surirella*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Fragilariaceae
GENUS *SYNEDRA* Ehrenberg, 1830 (fig. 43)

MORPHOLOGY

Cells are narrow and generally very elongate. They are solitary or in tufted, fan-shaped, or radiating colonies. They are free floating or epiphytic, sessile, or contained in a gelatinous stalk. Cells are linear to lanceolate, generally straight but sometimes slightly curved. Poles may be attentuated and sometimes capitate. Transverse striae are lateral to a conspicuous narrow pseudoraphe. The central area may be smooth or striated. The two chromatophores are discoid.

REPRODUCTION

Either 1 or 2 auxospores may be formed within a cell. A "regeneration" cell, which increases the size of the cell, has been observed by Gemeinhardt (1926).

OCCURRENCE

Synedra is widely distributed and is found in all types of waters. The commonly occurring species generally occur in circumneutral water of moderate to high conductivity, including brackish water. The genus is generally indicative of mesotrophic to eutrophic conditions. It is found in the euplankton, tychoplankton, and periphyton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 37.0	14.5	8.8
pH	3.7 – 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	.2 – 20.7	9.4	2.4
Specific conductance, micromho	10 –49,800	671	2,050
Total alkalinity, milligrams per liter	3 – 491	105	79
Total hardness, do	2 – 1,900	180	223
Total nitrogen, do	.00– 41.0	1.38	1.81
Total phosphorus, do	.0 – 4.0	.2	.3

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

FIGURE 43. – Drawing of *Synedra*.

Division Chrysophyta
Class Bacillariophyceae
Order Pennales
Family Tabellariaceae
GENUS *TABELLARIA* Ehrenberg, 1840 (fig. 44)

MORPHOLOGY

Cells generally are joined into zigzag chains but sometimes into stellate colonies. They are free floating. Valves have numerous intercalary bands between the girdles. Between the girdles and intercalary bands are longitudinal septa penetrating to the center of the cell. Valves are elongate and have an evident, medial inflation. They are slightly inflated at the poles. There is a narrow pseudoraphe that has lateral, transverse striae. Chromatophores are numerous small discs.

REPRODUCTION

Either 1 (Geitler, 1927) or 2 (Schütt, 1896) auxospores may form within a single cell.

OCCURRENCE

The genus is of widespread distribution in the euplankton. The most common species, *Tabellaria fenestrata*, is indicative of mesotrophic to eutrophic conditions. The genus generally occurs in circumneutral, shallow waters.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 31.0	12.4	8.1
pH	3.9 – 8.9	7.3	.7
Dissolved oxygen, milligrams per liter	1.2 – 16.7	10.0	2.4
Specific conductance, micromho	16 –6,860	221	391
Total alkalinity, milligrams per liter	3 – 320	64	58
Total hardness, do	5 –1,500	87	121
Total nitrogen, do	.01– 11.0	.87	1.08
Total phosphorus, do	.0 – 2.7	.1	.2

SPECIES INFORMATION

Refer to Boyer (1927a) and Patrick and Reimer (1966).

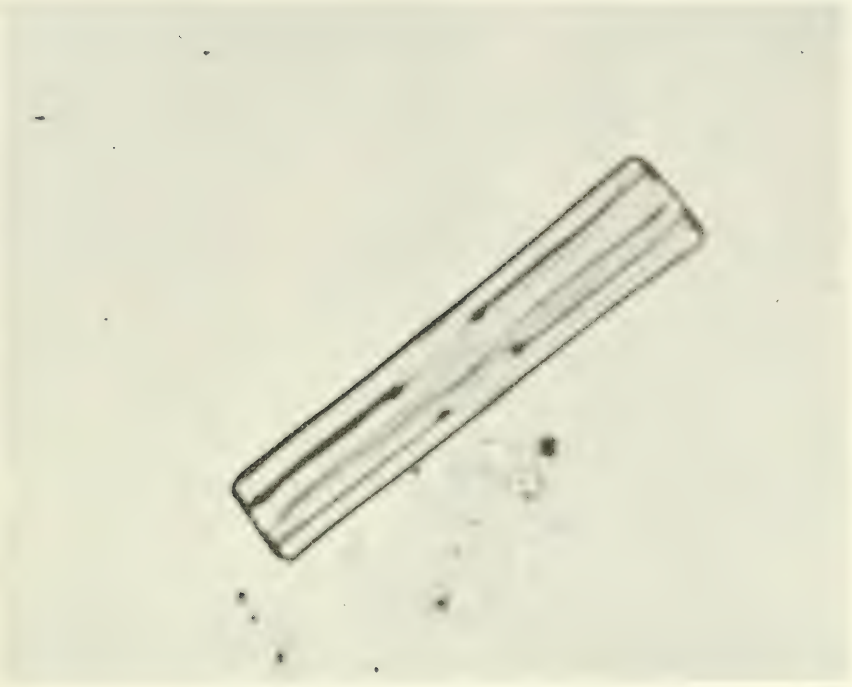

FIGURE 44.—Photomicrograph of *Tabellaria*.

Division Pyrrophyta
Class Dinophyceae
Order Peridiniales
Family Glenodiniaceae
GENUS *GLENODINIUM* Stein, 1883 (fig. 45)

MORPHOLOGY

Solitary, motile cells are asymmetrically globose but may be slightly dorsoventrally flattened. The cell is surrounded by a definite number of plates arranged in a specific manner. Cell wall is divided near the center into an apical epitheca and an antapical hypotheca. Epitheca has 2–9 apical, 0–4 anterior intercalary, and 6–12 precingular plates; hypotheca has 5–12 postcingular, 0–2 posterior intercalary, and 1–2 antapical plates. A longitudinal sulcus extends from the girdle into the hypotheca. There are 2 flagella. A prominent eyespot may be present. Numerous chromatophores are brown.

REPRODUCTION

Reproduction is isogamous by the union of gymnodinoid gametes. Each zygote forms 4 zoospores.

OCCURRENCE

The genus is generally found in the tychoplankton; however, it can occur in the euplankton. It seems to prefer soft-water conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	17.5	9.6
pH	4.6 – 9.2	7.6	.7
Dissolved oxygen, milligrams per liter	.1 – 22.0	8.6	3.1
Specific conductance, micromho	11 – 42,100	1,400	4,570
Total alkalinity, milligrams per liter	0 – 477	120	80
Total hardness, do	6 – 1,700	219	248
Total nitrogen, do	.00 – 11.0	1.26	1.17
Total phosphorus, do	.0 – 3.2	.1	.2

SPECIES INFORMATION

Refer to Schiller (1933) and Prescott (1962).

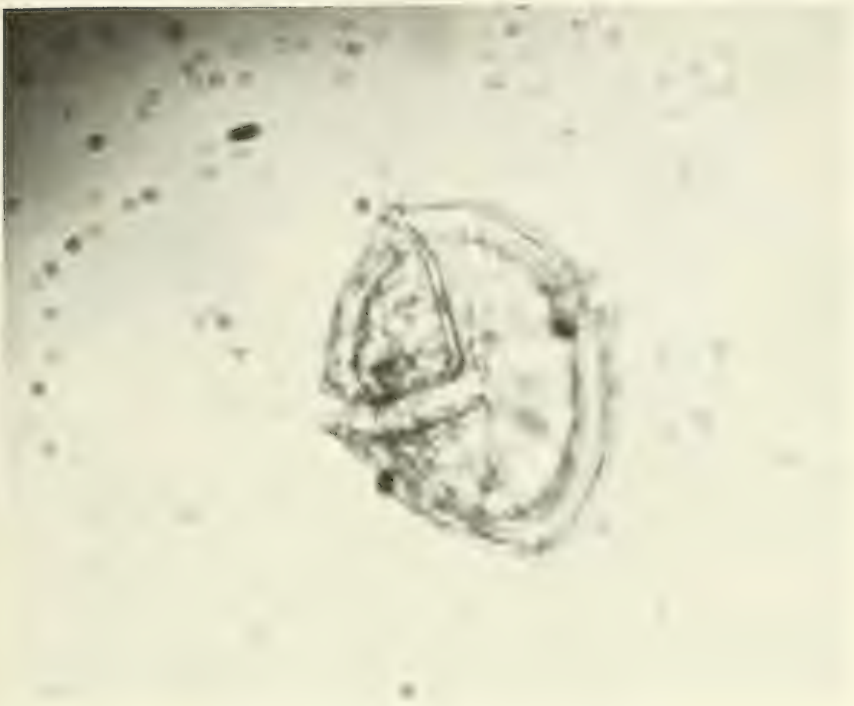

FIGURE 45.—Photomicrograph of *Glenodinium*.

Division Pyrrophyta
Class Dinophyceae
Order Peridiniales
Family Peridiniaceae

GENUS *PERIDINIUM* Ehrenberg, 1830; emend., Stein, 1883 (fig. 46)

MORPHOLOGY

Solitary, motile cells are spherical, ovoid, or angular and may or may not have short apical and antapical horns. The cell is surrounded by a definite number of plates arranged in a specific manner. Cell wall is divided near the center into an apical epitheca and an antapical hypotheca. Epitheca has 4 apical, 2–3 anterior intercalary, and 7 precingular plates; hypotheca has 5 postcingular and 2 antapical plates. A longitudinal sulcus extends from the girdle into the hypotheca. There are 2 flagella. A prominent eyespot may be present. Numerous chromatophores are brown.

REPRODUCTION

Aplanospores are formed by division of the protoplast.

OCCURRENCE

The alga is of widespread distribution in the euplankton and tychoplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.0	18.6	9.2
pH	4.6 – 9.6	7.6	.7
Dissolved oxygen, milligrams per liter	.8 – 18.7	8.5	2.8
Specific conductance, micromho	26 –30,000	881	2,480
Total alkalinity, milligrams per liter	3 – 477	113	85
Total hardness, do	5 – 2,000	197	241
Total nitrogen, do	.05– 13.0	1.10	1.10
Total phosphorus, do	.0 – 2.2	.1	.2

SPECIES INFORMATION

Refer to Lefèvre (1932) and Prescott (1962).

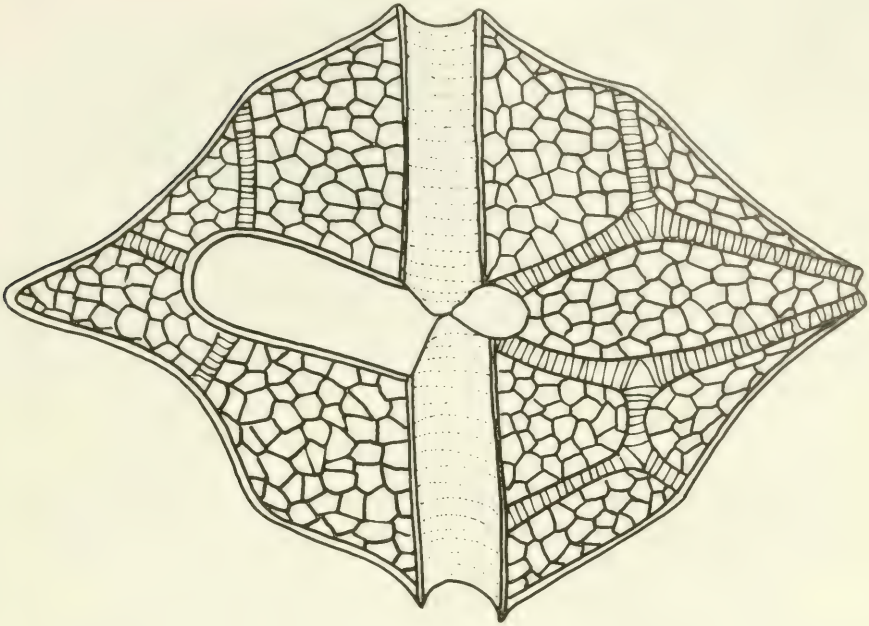

FIGURE 46.—Drawing of *Peridinium*.

Division Cryptophyta
Class Cryptophyceae
Order Cryptomonidales
Family Cryptochrysidaceae
GENUS *CHROOMONAS* Hansgrirg, 1892 (fig. 47)

MORPHOLOGY

Solitary, motile cells are compressed. The anterior end is truncated, and the posterior end is rounded. A longitudinal furrow is at the anterior end near the point of insertion of 2 unequal flagella. An eyespot and granules may be present. The single laminate chromatophore is blue green.

REPRODUCTION

Longitudinal division of the protoplast results in the formation of 2 daughter cells. Rosenberg (1944) observed a palmella stage.

OCCURRENCE

The alga is common in shallow waters and among algal masses and decaying vegetation (Prescott, 1962).

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.5	16.5	9.0
pH	4.3 – 8.9	7.7	.7
Dissolved oxygen, milligrams per liter	.1 – 17.0	8.9	2.9
Specific conductance, micromho	21 – 47,800	1,110	4,030
Total alkalinity, milligrams per liter	0 – 477	128	82
Total hardness, do	4 – 1,700	209	198
Total nitrogen, do	.01 – 24.0	1.25	1.73
Total phosphorus, do	.0 – 3.5	.1	.2

SPECIES INFORMATION

Refer to Lackey (1939), Pascher (1913), and Prescott (1962).

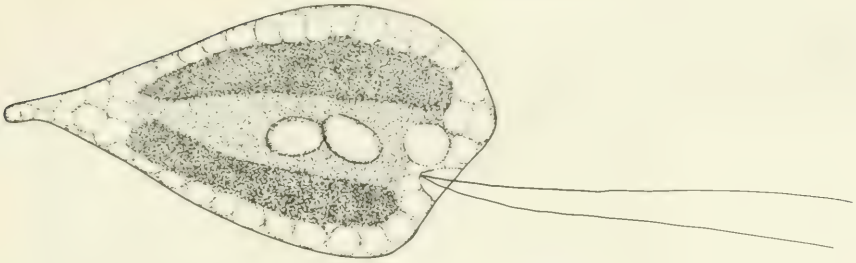

FIGURE 47.—Drawing of *Chroomonas*.

Division Cryptophyta
Class Cryptophyceae
Order Cryptomonidales
Family Cryptomonodaceae
GENUS *CRYPTOMONAS* Ehrenberg, 1831 (fig. 48)

MORPHOLOGY

Solitary, free-swimming cells are compressed, somewhat elliptical, and broadly rounded to truncate at the anterior end. Two unequal flagella are inserted into an evident gullet, which may be lined with granular trichoblasts. A contractile vacuole is next to the gullet. The 1 to 2 large chromatophores are yellow to olive green but are sometimes red.

REPRODUCTION

A mucilage surrounds an immobile stage prior to longitudinal division into 2 daughter cells.

OCCURRENCE

Cryptomonas is found in the euplankton and tychoplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 34.0	16.3	8.8
pH	4.1 – 9.7	7.8	.6
Dissolved oxygen, milligrams per liter	.2 – 22.0	9.0	2.9
Specific conductance, micromho	20 – 41,000	862	1,910
Total alkalinity, milligrams per liter	0 – 477	144	78
Total hardness, do	3 – 2,000	248	228
Total nitrogen, do	.01 – 19.0	1.52	1.59
Total phosphorus, do	.0 – 3.9	.2	.3

SPECIES INFORMATION

Refer to Pascher (1913) and Prescott (1962).

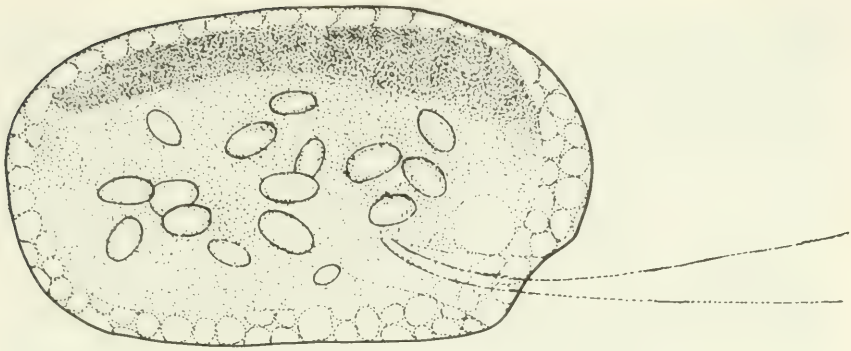

FIGURE 48. – Drawing of *Cryptomonas*.

Division Cyanophyta
Class Cyanophyceae
Order Chyroococcales
Family Chroococcaceae
GENUS *AGMENELLUM* Drouet and Daily, 1956 (fig. 49)

Generic Synonym.—*Merismopedia* Meyen, 1839

MORPHOLOGY

Cells are spherical or almost hemispherical when dividing. They are contained in free-floating, multicelled colonies. Cells, 3–6 μm wide, are regularly arranged in parallel vertical and transverse rows. The colony is 1 cell in thickness. The gelatinous matrix is homogeneous and colorless.

REPRODUCTION

Reproduction is by cell division and colony fragmentation.

OCCURRENCE

Agmenellum is widely distributed and generally is indicative of soft-water and acidic conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	22.5	7.2
pH	5.6 – 9.4	7.7	.6
Dissolved oxygen, milligrams per liter	.1 – 20.6	8.2	2.4
Specific conductance, micromho	26 – 39,500	1,190	2,720
Total alkalinity, milligrams per liter	1 – 450	120	78
Total hardness, do	4 – 2,000	241	272
Total nitrogen, do	.01– 21.0	1.52	1.63
Total phosphorus, do	.0 – 3.1	.2	.3

SPECIES INFORMATION

Refer to Thompson (1938), Geitler (1930), and Prescott (1962).

FIGURE 49. – Photomicrograph of *Agmenellum*.

Division Cyanophyta
Class Cyanophyceae
Order Hormogonales
Family Nostocaceae
GENUS *ANABAENA* Bory, 1822 (fig. 50)

MORPHOLOGY

Cells are spherical to barrel shaped, are homogeneous or granulose, and sometimes contain pseudovacuoles. They are united into free-floating, beadlike trichomes that are solitary or aggregated. Trichomes are cylindrical or slightly attentuated at the apices. They may be straight, circinate, or spirally or irregularly twisted. Intercalary heterocysts are spherical. Akinetes are variously shaped.

REPRODUCTION

Reproduction is by heterocysts and akinetes.

OCCURRENCE

The genus is found commonly in the euplankton and tychoplankton of hard water or eutrophic water during periods of high temperature. It is a frequent component of algal blooms and is indicative of hard water having a high nutrient content when occurring with *Aphanizomenon* or *Anacystis*.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 37.0	20.1	7.7
pH	4.4 – 9.6	7.6	.7
Dissolved oxygen, milligrams per liter	.4 – 19.0	8.3	2.3
Specific conductance, micromho	12 –30,000	717	1,650
Total alkalinity, milligrams per liter	0 – 371	102	73
Total hardness, do	5 – 1,600	173	195
Total nitrogen, do	.00– 18.0	1.34	1.64
Total phosphorus, do	.0 – 3.5	.2	.4

SPECIES INFORMATION

Refer to Geitler (1932) and Prescott (1962).

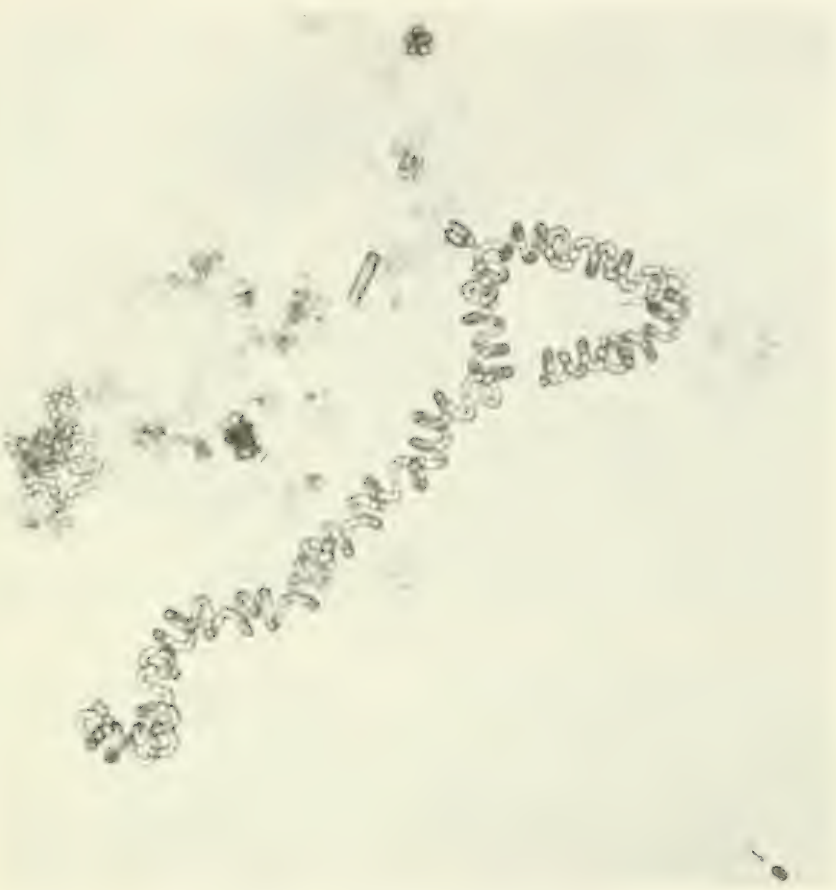

FIGURE 50. – Photomicrograph of *Anabaena*.

Division Cyanophyta
Class Cyanophyceae
Order Chroococcales
Family Chroococcaceae

GENUS *ANACYSTIS* Meneghini, 1837; emend., Daily, 1942 (fig. 51)

Generic Synonyms.—*Microcystis* Kützing, 1833; *Polycystis* Kützing, 1849; *Clathrocystis* Henfrey, 1956.

MORPHOLOGY

Cells are spherical or almost hemispherical when dividing and range from 2 to 10 μm in diameter. They are irregularly and densely aggregated in a free-floating, colonial, gelatinous matrix. Colonies are amorphous.

REPRODUCTION

Reproduction is by cell division and colony fragmentation.

OCCURRENCE

Anacystis is very common in hard water or eutrophic water during periods of high temperature. It is a frequent component of algal blooms and is notorious as a spoiler of water for domestic uses, swimming, and other forms of recreation. The alga often causes death of fish in heavily infested lakes. It is indicative of hard water with high nutrient content when occurring in large numbers with *Aphanizomenon* or *Anabaena*.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	19.1	8.1
pH	3.7 – 10.0	7.6	.7
Dissolved oxygen, milligrams per liter	.1 – 20.7	8.5	2.4
Specific conductance, micromho	10 –48,000	866	2,180
Total alkalinity, milligrams per liter	0 – 500	113	81
Total hardness, do	2 – 2,000	207	246
Total nitrogen, do	.00– 41.0	1.46	1.70
Total phosphorus, do	.0 – 3.9	.2	.3

SPECIES INFORMATION

Refer to Daily (1942), Elenkin (1924), Drouet and Daily (1939), Teiling (1946), and Prescott (1962).

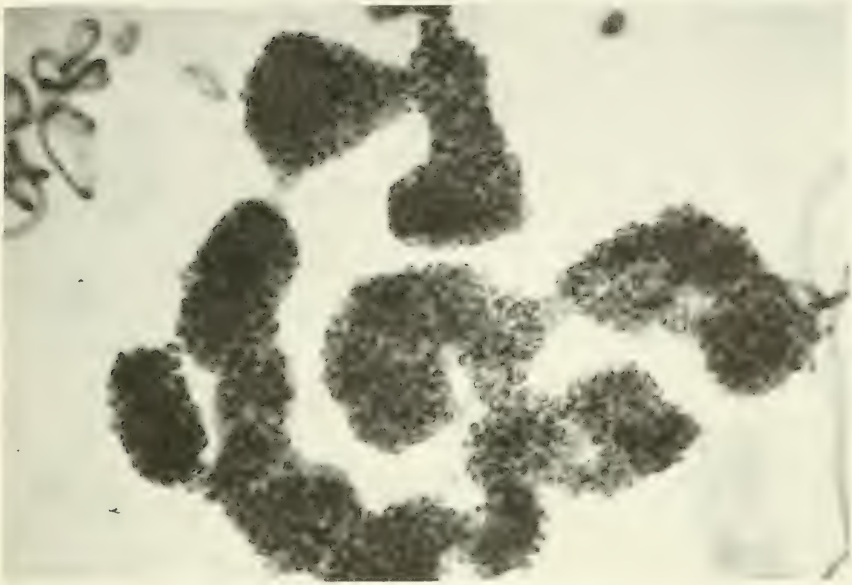

FIGURE 51. – Photomicrograph of *Anacystis*.

Division Cyanophyta
Class Cyanophyceae
Order Hormogonales
Family Nostocaceae
GENUS *APHANIZOMENON* Morren, 1838 (fig. 52)

MORPHOLOGY

Cells are cylindrical or barrel shaped and rarely exceed 5 μm in diameter. They are united into straight or slightly curved trichomes, which are laterally agglutinated by indistinct sheaths. Trichomes are free floating. Intercalary heterocysts are cylindrical. Akinetes are cylindrical.

REPRODUCTION

Reproduction is by heterocysts and akinetes.

OCCURRENCE

The single species, *Aphanizomenon flos-aquae*, is so consistently related to hard water that it may be used as an index organism for high pH and high contents of nitrogen, phosphorus, and carbonate. It is a notorious component of algal blooms and occurs commonly with *Anabaena* and *Anacystis*.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	19.2	8.3
pH	4.6 – 9.6	7.7	.6
Dissolved oxygen, milligrams per liter	2.0 – 18.7	8.4	2.3
Specific conductance, micromho	11 –42,000	877	2,870
Total alkalinity, milligrams per liter	3 – 311	109	68
Total hardness, do	6 – 1,700	193	203
Total nitrogen, do	.05– 24.0	1.61	2.12
Total phosphorus, do	.0 – 3.1	.2	.3

SPECIES INFORMATION

Refer to Smith (1920) and Prescott (1962).

FIGURE 52.—Photomicrograph of *Aphanizomenon*.

Division Cyanophyta
Class Cyanophyceae
Order Hormongonales
Family Nostocaceae
GENUS *CYLINDROSPERMUM* Kützing, 1843 (fig. 53)

MORPHOLOGY

Cells are cylindrical and united into short, straight trichomes. Cells range from 2 to 5 μm in diameter. Trichomes are free floating or found on moist soil. Heterocysts are cylindrical and always terminal. Akinetes are contiguous to heterocysts.

REPRODUCTION

Reproduction is by heterocysts and akinetes.

OCCURRENCE

The genus commonly occurs in the tychoplankton and periphyton. The more common species occur in hard-water, alkaline conditions.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	1.5 – 34.0	24.2	6.3
pH	5.9 – 9.1	7.6	.7
Dissolved oxygen, milligrams per liter	1.7 – 20.0	7.6	2.3
Specific conductance, micromho	35 –12,000	999	1,470
Total alkalinity, milligrams per liter	3 – 430	107	73
Total hardness, do	6 – 1,600	235	239
Total nitrogen, do	.10– 18.0	1.39	1.80
Total phosphorus, do	.0 – 2.7	.2	.3

SPECIES INFORMATION

Refer to Geitler (1932) and Prescott (1962).

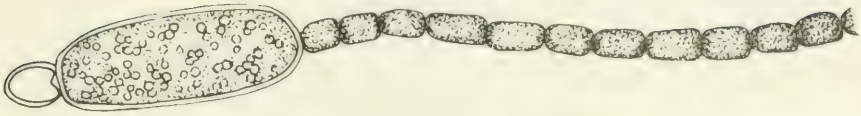

FIGURE 53. – Drawing of *Cylindrospermum*.

Division Cyanophyta
Class Cyanophyceae
Order Chroococcales
Family Chroococcaceae
GENUS *GOMPHOSPHAERIA* Kützing, 1836 (fig. 54)

MORPHOLOGY

Cells are pyriform, obovoid, or cylindrical; when dividing, they are heart shaped or obcuniform. Cells are peripherally distributed in a single layer with long axes radiating in a globous colony. Each cell has a distinct individual sheath, and each has a gelatinous projection at its base. Projections from all cells are joined toward the center of the colony. The colonial matrix is gelatinous.

REPRODUCTION

Reproduction is by cell division and colony fragmentation.

OCCURRENCE

The genus is of widespread distribution in the euplankton and tychoplankton of both soft-water and hard-water bodies.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 33.5	19.6	8.2
pH	4.9 – 9.2	7.7	.6
Dissolved oxygen, milligrams per liter	.4 – 18.4	8.6	2.5
Specific conductance, micromho	32 –9,230	556	796
Total alkalinity, milligrams per liter	4 – 426	111	73
Total hardness, do	9 –1,400	173	158
Total nitrogen, do	.01– 6.7	1.24	.99
Total phosphorus, do	.0 – 3.5	.1	.2

SPECIES INFORMATION

Refer to Smith (1920) and Prescott (1962).

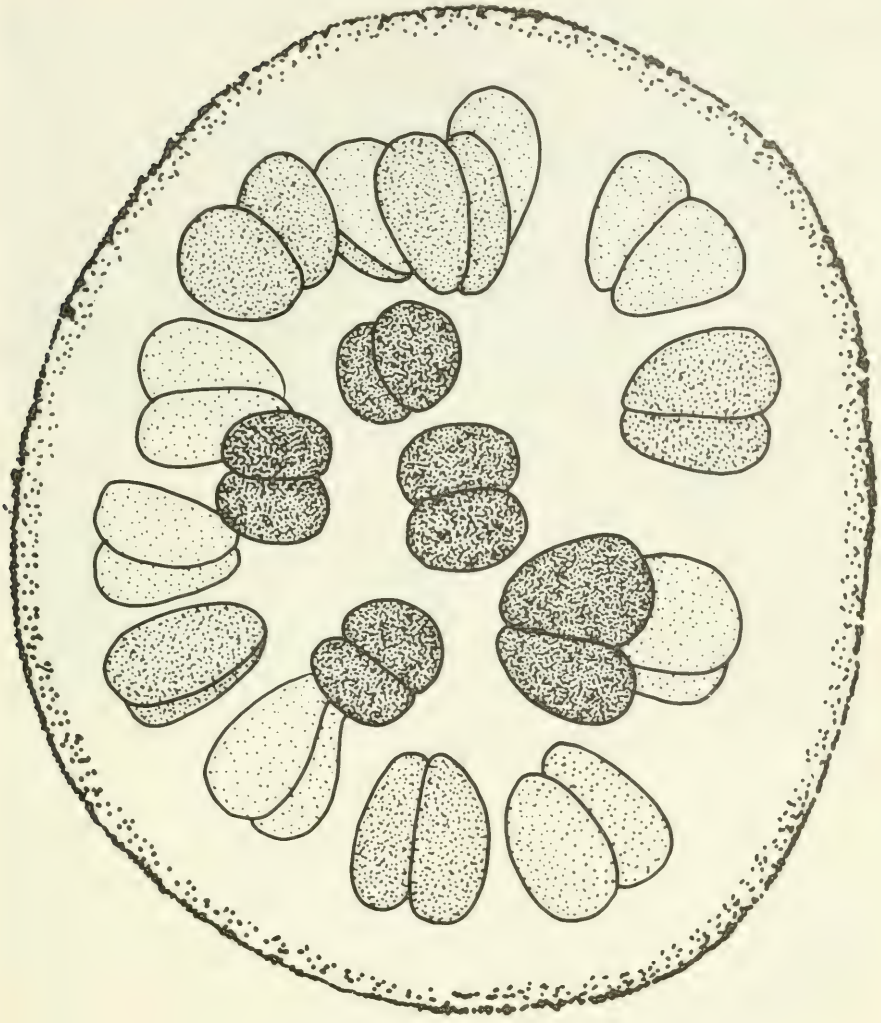

FIGURE 54. – Drawing of *Gomphosphaeria*.

Division Cyanophyta
Class Cyanophyceae
Order Hormogonales
Family Oscillatoriaceae
GENUS *LYNGBYA* Agardh, 1824 (fig. 55)

MORPHOLOGY

Cells are discoidal and adjoined at the flat faces into long trichomes. Trichomes are unbranched, uniseriate, the same diameter from base to apex, and contained in firm, conspicuous sheaths. Filaments are straight, curved, or twisted and may be solitary or densely intertwined into floccose masses. They may be free floating or epiphytic. Heterocysts and akinetes are lacking.

REPRODUCTION

Reproduction is by hormogonia.

OCCURENCE

The genus is found commonly in eutrophic waters, and it is generally indicative of hard water. It can occur in great numbers in eutrophic lakes, where it remains distributed through the water column. It is found in both the euplankton and tychoplankton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature_____degrees Celsius__	0.0 – 34.5	16.7	9.9
pH_____	4.1 – 9.2	7.5	.7
Dissolved oxygen_____milligrams per liter__	.1 – 20.6	8.7	2.8
Specific conductance_____micromho__	24 –48,000	952	2,440
Total alkalinity_____milligrams per liter__	0 – 478	113	83
Total hardness_____do_____	3 – 2,000	216	256
Total nitrogen_____do_____	.01– 18.0	1.58	1.82
Total phosphorus_____do_____	.0 – 4.0	.2	.4

SPECIES INFORMATION

Refer to Gomont (1892a), Geitler (1932), and Prescott (1962).

FIGURE 55. – Photomicrograph of *Lyngbya*.

Division Cyanophyta
Class Cyanophyceae
Order Hormogonales
Family Oscillatoriaceae
GENUS *OSCILLATORIA* Vaucher, 1803 (fig. 56)

MORPHOLOGY

Cells are discoidal and adjoined at the flat surfaces into long trichomes. Trichomes are unbranched, uniseriate, and sometimes apically attenuated. Sheaths are not evident. Filaments are straight, curved, or contorted and may be solitary or in floccose masses. They are free floating or epiphytic. Heterocysts and akinetes are lacking.

REPRODUCTION

Reproduction is by hormogonia.

OCCURRENCE

Oscillatoria is one of the most ubiquitous of the algal genera. It is widely distributed in all types of waters and is found commonly in the euplankton, tychoplankton, and periphyton.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	16.9	9.3
pH	3.4 – 9.8	7.6	.7
Dissolved oxygen, milligrams per liter	.1 – 22.0	8.8	2.7
Specific conductance, micromho	10 –48,000	923	2,210
Total alkalinity, milligrams per liter	0 – 500	119	81
Total hardness, do	3 – 2,000	223	257
Total nitrogen, do	.00– 28.0	1.68	2.07
Total phosphorus, do	.0 – 3.9	.2	.4

SPECIES INFORMATION

Refer to Gomont (1892a, b) and Prescott (1962).

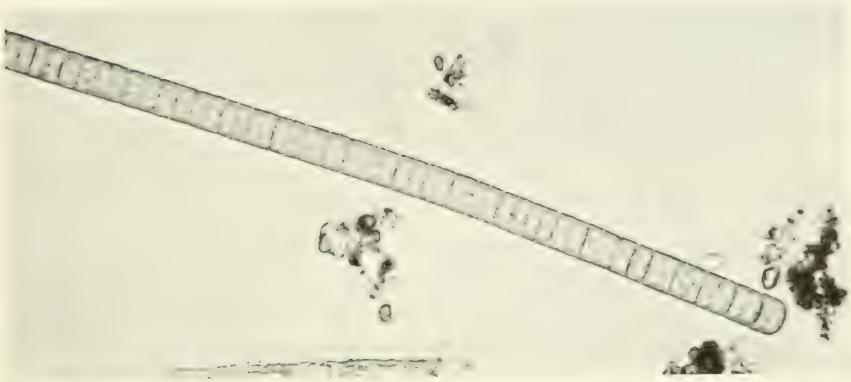

FIGURE 56. – Photomicrograph of *Oscillatoria*.

Division Cyanophyta
Class Cyanophyceae
Order Hormogonales
Family Oscillatoriaceae

GENUS *PHORMIDIUM* Kützing, 1843 (fig. 57)

MORPHOLOGY

Cells are discoidal and adjoined at the flat surfaces into trichomes. Trichomes are unbranched, cylindrical, and enclosed by watery gelatinous sheaths, which are partially or wholly confluent. Apices are varied, sometimes capitate, often having calyptra. The plant mass is aquatic or subaerial; it often forms an extensive stratum.

REPRODUCTION

Reproduction is by hormogonia.

OCCURRENCE

The genus is found primarily on moist rocks or damp soil (Smith, 1950); however, it is commonly found in the euplankton, tychoplankton, and periphyton. It occurs most commonly in hard water.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 32.5	20.4	8.5
pH	4.8 – 8.8	7.6	.6
Dissolved oxygen, milligrams per liter	1.2 – 13.3	7.7	2.5
Specific conductance, micromho	30 –48,000	999	4,080
Total alkalinity, milligrams per liter	0 – 363	114	75
Total hardness, do	7 – 1,200	204	216
Total nitrogen, do	.02– 13.0	1.50	1.93
Total phosphorus, do	.0 – 3.3	.2	.4

SPECIES INFORMATION

Refer to Gomont (1892a, b), Geitler (1932), and Prescott (1962).

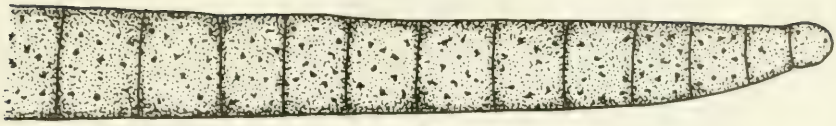

FIGURE 57. – Drawing of *Phormidium*.

Division Cyanophyta
Class Cyanophyceae
Order Hormogonales
Family Rivulariaceae

GENUS *RAPHIDIOPSIS* Fritsch and Rich, 1929 (fig. 58)

MORPHOLOGY

Cells are cylindrical and about 4.5 μm in diameter. They are 1.5–2 times as long as wide. The solitary, free-floating trichomes are relatively short. The sheath is absent. Both poles of a trichome may be tapered, or one pole may be tapered and the other, broadly rounded. Numerous pseudovacuoles may be present. Akinetes are barrel shaped and are located in the middle of the trichome.

REPRODUCTION

The trichome breaks transversely into equal halves. Akinetes may be found midway in the trichome.

OCCURRENCE

The trichomes of the genus are free floating.

ENVIRONMENTAL CONDITIONS

	Range	Mean	Standard deviation
Temperature, degrees Celsius	0.0 – 36.0	19.7	8.7
pH	4.9 – 9.1	7.6	.7
Dissolved oxygen, milligrams per liter	.1 – 15.0	8.1	2.5
Specific conductance, micromho	20 – 48,000	783	2,810
Total alkalinity, milligrams per liter	1 – 483	105	83
Total hardness, do	4 – 1,500	179	200
Total nitrogen, do	.06– 9.8	1.43	1.42
Total phosphorus, do	.0 – 3.5	.2	.3

SPECIES INFORMATION

Refer to Fritsch and Rich (1929) and Daily (1945).

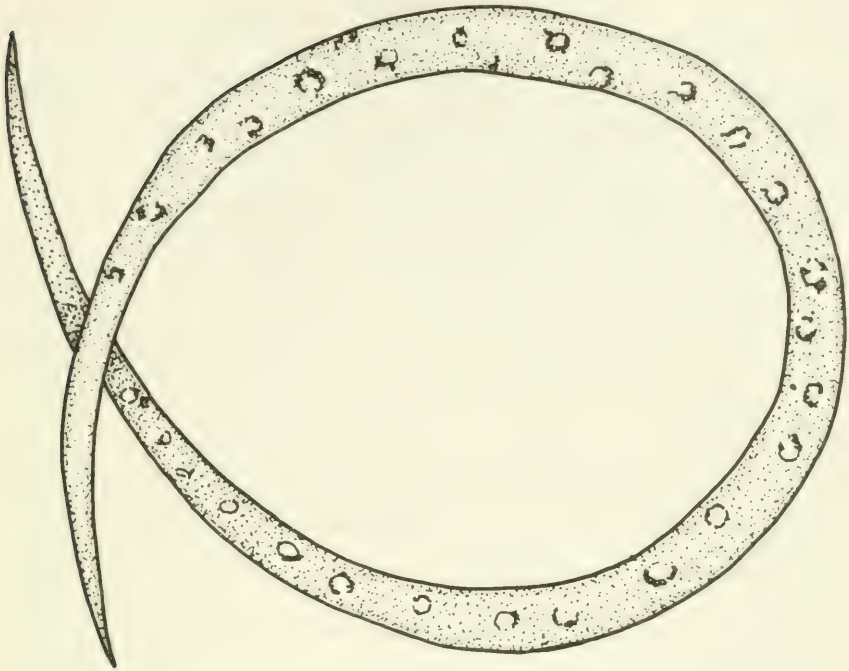

FIGURE 58. – Drawing of *Raphidiopsis*.

GLOSSARY

[adj, adjective; n, noun; v, verb]

Acicular (adj). Slenderly needle shaped.
Adiametric (adj). Having unequal diameters.
Agglutinate (adj). Adherent; sticking together.
Aggregate (adj). Massed together.
Akinete (n). A nonmotile spore, formed directly from a vegetative cell.
Alga, algae (n), **algal** (adj). A group of plants, mostly aquatic, single celled, colonial, or multicelled, containing chlorophyll and lacking roots, stems, and leaves.
Amorphous (adj). Lacking a definite shape.
Anapex (n), **anapical** (adj). The bottom or end opposite the apex.
Anisogamy (n), **anisogamous** (adj). The sexual union of two flagellated or nonflagellated gametes of unequal sizes.
Anterior (adj). At or toward the front.
Antherozoid (n). A male gamete.
Apex (n), **apical** (adj). The top or anterior end.
Aplanospore (n). A nonmotile spore formed from all or part of the protoplast of a vegetative cell and having a wall distinctly different from that of the parent cell.
Apposed (adj). Paired; opposite but in a definite relation to one another.
Arcuate (adj). Moderately curved like a bow.
Asymmetrical (adj). Not symmetrical.
Attenuated (adj). Tapering at the end.
Autospore (n). An aplanospore having the same shape as the vegetative cell from which it was formed.
Auxospore (n). A spore formed by asexual metamorphosis of the protoplast of one cell or resulting from the sexual fusion of two protoplasts or nuclei; occurs only in diatoms.
Biflagellate (adj). Having two flagella.
Bifurcate (adj). Divided into two parts or branches.
Bipartition (adj). Divided into two parts.
Calyptra (n). A hood- or cap-shaped covering, sometimes occurring on apical cells of filaments.
Campanulate (adj). Bell shaped.
Capitate (adj). Having a knoblike end.
Chloroplast (n). A body in the cell containing chlorophyll as the dominant pigment; *see* chromatophore.
Chromatophore (n). A body in the cell containing the pigments; *see* chloroplast.
Circinate (adj). Rolled inward from the apex.
Citriform (adj). Lemon shaped.
Clevate (adj). Club shaped.
Coenobium, coenobia (n). A colony in which a definite number of cells are arranged in a specific way.
Coenocyte (n), **coenocytic** (adj). A multinucleate vegetative cell or nonseptate thallus.
Colony (n), **colonial** (adj). A group of individuals joined together by a common sheath or gelatinous material; a group of cells forming a filament or trichome.
Concentric (adj). Having a common center.
Conical (adj). Cone shaped.
Conjugation (n), **conjugate** (v). The union of gametes.
Contractile (adj). Having the ability to contract or expand.
Costa, costae (n), **costate** (adj). A rib or ribbed structure.
Cuneate (adj). Wedge shaped.
Dichotomous (adj). Divided or branched into two parts; branched.
Diffuse (adj). Generalized; not localized.

Discoid (adj). Disc shaped.
Epitheca, epithecae (n). The larger or epivalve of a diatom cell; part of the wall of a dinoflagellate, anterior to the transverse furrow.
Euplankton (n). True plankton.
Eyespot (n). A small pigmented photosensitive body in certain flagellated algal cells.
Fascicle (n), **fasciculate** (adj). A bundle or cluster.
Filament (n), **filamentous** (adj). A linear arrangement of cells.
Flagellum, flagella (n), **flagellate** (adj). A fine long threadlike structure having lashing or undulating movement, projecting from a cell; it is used for locomotion.
Frustule (n). A diatom cell; the silicified wall of the diatom cell.
Furcate (adj). Forked.
Fusiform (adj). Spindle shaped.
Gamete (n), **gametic** (adj). A sex cell.
Gelatinous (adj). Having a jellylike or mucilagelike texture or appearance.
Gibbose (adj). Swollen on one side.
Girdle (n). A ring or band connecting two valves in diatoms; a transverse groove.
Globose (adj). Ball shaped or nearly so.
Granulate, granulose (adj). Composed of or appearing to be covered with granules.
Gullet (n). An anterior opening of flagellates.
Heterocyst (n). A metamorphosed vegetative cell in diatoms; sometimes forms endospores or a filament.
Heterothallus (n), **heterothallic** (adj). A species in which gametes unite only if arising from different plants.
Homothallus (n), **homothallic** (adj). A species in which gametes unite only if arising within the same plant.
Hormogonium, hormogonia (n). A short, distinct section of a trichome that produces a new plant vegetatively.
Hyaline (adj). Colorless and transparent.
Hypotheca, hypothecae (n). The small or hypovalve of a diatom cell; part of the wall of a dinoflagellate, posterior to the transverse furrow.
Inflated (adj). Swollen.
Intercalary (adj). Between or inserted between cells.
Isodiametric (adj). Having equal diameters.
Isogamy (n), **isogamous** (adj). Sexual union of two flagellated or nonflagellated gametes of equal size.
Keel (n). A projecting ridge.
Laminate (adj). Consisting of or shaped like plates.
Lanceolate (adj). Lance shaped.
Linear (adj.). Straight; narrow and long.
Lorica (n). A firm covering that is not connected to the protoplast and contains an anterior opening.
Lunate (adj). Crescent shaped.
Macrophyte (n). Large plants that can be seen without magnification; includes mosses and seed plants.
Mucilage (n). A thick, watery substance.
Multiseriate (adj). Occurring in several rows.
Naviculoid (adj). Boat shaped.
Nodule (n). A small knob.
Obcuniform (adj). Inversely wedge shaped.
Obovoid (adj). Inversely ovoid, with the broader end anterior or outermost.
Oogamy (n). **oogamous** (adj). Sexual union of a small motile male gamete (sperm) with a large nonmotile female gamete (egg).

Ovate, ovoid (adj). Oval; egg shaped.
Palmella (n), **palmelloid** (adj). A genus of green algae, whose spherical cells are united by their mucilage coats into indefinite mucilaginous masses.
Parietal (adj). Pertaining to or near the wall.
Periphery (n). The outer boundary or edge.
Periphyton (n), **periphytic** (adj). The community of micro-organisms that are attached to or live upon submerged surfaces.
Phytoplankton (n), **phytoplanktonic** (adj). The plant part of the plankton.
Plankton (n), **planktonic** (adj). The community of suspended or floating organisms that drift passively with water currents.
Polar (adj). Pertaining to the pole or end.
Polyhedral (adj). Having numerous faces or planes.
Postcingular (adj). Referring to position of plates adjacent to the girdle of the hypotheca of certain dinoflagellates.
Precingular (adj). Referring to position of plates adjacent to the girdle in the epitheca of certain dinoflagellates.
Protoplast (n). The living contents of a cell; the nucleus, cytoplasm, and plasma membrane that constitute a living unit.
Pseudoraphe (n). The axial field of the valves of pennate diatoms lacking a longitudinal cleft or raphe.
Pseudovacuole (n). A false vacuole; a pocket of gas or fluid within the protoplast.
Puncta, punctae (n), **punctate** (adj). A tiny spot, dot, point, or depression.
Pyramidal (adj). Pyramid shaped.
Pyriform (adj). Pear shaped.
Quadrate (adj). Square; arranged in fours.
Quadriflagellate (adj). Having four flagella.
Radial (adj). Radiating from a common center or point; pertaining to the radius.
Raphe (n), **rapheal** (adj). A longitudinal cleft in the axial field of certain pennate diatoms.
Recurved (adj). Curved; bent down.
Reniform (adj). Kidney shaped.
Reticulate (adj). Like a network.
Rhombic (adj). Resembling a rhomboid.
Rostrate (adj). Having a beak.
Semicell (n). One-half of a vegetative cell of a desmid.
Sessile (adj). Pertaining to an organism that is attached to an object.
Seta, setae (n). A slender, more or less rigid bristle, a short hair.
Sheath (n). A covering, envelope, or tube that is composed of mucilage.
Sigmoid (adj). S-shaped.
Solitary (adj). Single; alone.
Spherical (adj). Sphere shaped; globular.
Spicate (adj). Having spikes or spines.
Spine (n). A stiff, pointed process.
Stalk (n). A supporting structure, generally mucilage, affixed to a substrate.
Statospore (n). An asexually formed spore having thick silicified walls composed of two overlapping halves.
Stauros (n). A thickness and transversely expanded central nodule interrupting the raphe of certain diatoms.
Stellate (adj). Star shaped.
Stria, striae (n), **striate** (adj). Long delicate markings on the frustules of diatoms.
Subacute (adj). Almost pointed.
Subcylindrical (adj). Almost cylindrical in shape.

Subelliptical (adj). Almost elliptical in shape.
Subpolar (adj). Near the pole, end, or apex.
Subspherical (adj). Almost spherical in shape.
Sulcus (n). A groove or furrow.
Suture (n). The seam or ridge formed by apposed margins.
Tabular (adj). Table shaped; having a flat surface.
Terminal (adj). At or near the end.
Trichome (n). A uniseriate row of cells in a filament; a filament exclusive of a gelatinous sheath.
Truncate (adj). Terminating abruptly by a nearly straight edge or surface.
Tychoplankton (n). Organisms in the plankton, which were scoured from the bottom.
Undulate (adj). Wavy.
Uniflagellate (adj). Having one flagellum.
Uniseriate (adj). In a single row.
Vacuole (n). An area in the protoplasm containing cell fluid and sometimes granules.
Valve (n). The silicified parts of a diatom cell.
Verrucose (adj). Covered with wartlike elevations.
Vesicule (n). A bladderlike structure.
Zoospore (n). A flagellated, asexually formed spore.
Zygote (n), **zygotic** (adj). A cell resulting from the union of two gametes or gametic nuclei.

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☆U.S. GOVERNMENT PRINTING OFFICE: 1982—361-614/311